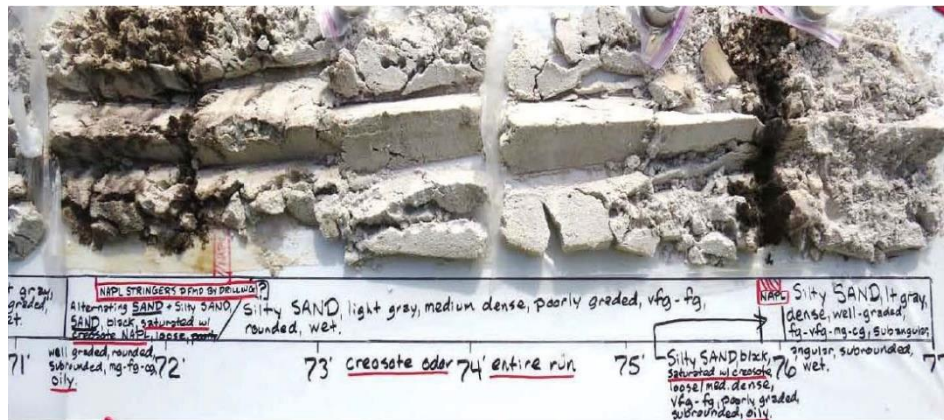


**TECHNICAL MEMORANDUM**  
**REMEDIAL DESIGN/REMEDIAL ACTION PLANNING SUPPORT**  
**ESCAMBIA WOOD TREATING SUPERFUND SITE, PENSACOLA, FL**



Final Report, 1 June 2021

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## EXECUTIVE SUMMARY

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This Technical Memorandum presents assessment and recommendations for pending remedial actions for Operable Unit 2 (OU2) – Groundwater at the Escambia Wood Treating (ETC) Superfund Site in Pensacola, Florida. Specifically, the U.S. Environmental Protection Agency (U.S. EPA) has tasked the US Army Corps of Engineers (USACE) with providing recommendations related to the following elements:

- Design characterization needs to support design and implementation of the Source Area (SA) and Highly Absorbed Phase Area (HAPA) components of the remedy;
- Technology Assessment for SA and HAPA components of the selected remedy;
- Remedial Design/Remedial Action Delivery Strategy for all components of the selected remedy considering remedial action funding limitations

The assessment presented in this Technical Memorandum considers the goals of the remedy, available site data, conceptual site model (CSM), remedy performance, protectiveness, cost-effectiveness, and closure strategy. The assessment included reviewing site documents, interviewing project team members, potentially visiting the site for one day, and compiling a report that includes recommendations. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation and represent the opinions of the evaluation team. These recommendations do not constitute requirements for future action, but rather are provided for consideration by U.S. EPA and other site stakeholders. Also note that while the recommendations may provide some details to consider during implementation, the recommendations are not meant to replace other, more comprehensive, planning documents such as work plans, sampling plans, and quality assurance project plans.

### Site-Specific Background

The ETC site was used for manufacturing treated wood products from approximately 1942 until 1982. Some minor cleanup/response actions were undertaken by the site owners prior to abandonment of the site in 1991. ETC was placed on the Superfund Program's National Priorities List in 1994 due to contamination of site soil and groundwater from the historical wood treating operations. The ETC site is currently undeveloped. Surrounding land use is primarily commercial/light industrial to the north, west, and south. Railroad tracks operated by CSX are present along the eastern border of the ETC site. Very recently, portions of the ETC site have been used for temporary storage/management of vegetative debris gathered from the community following Hurricane Sally in September 2020; storage and management of this debris concluded in January/February 2021.

U.S. EPA has completed extensive remediation efforts at the ETC site to-date; remediation efforts have been organized through designation of two OUs: OU1 – Source Control and OU-2 – Groundwater. One of the major remediation efforts for OU1 focused on excavation/consolidation of contaminated site soils into an on-site waste containment cell. Implementation of the OU1 remedy was substantially complete by 2010. Investigation and planning for groundwater remediation at OU2 included completion of a Remedial Investigation in 2005, Feasibility Study in 2008, and Record of Decision in 2008; however, during implementation of the OU1 remedy, the levels of groundwater contamination at Solid Waste Management Unit 10 (SMWU 10) were found to be much more significant than previously understood. In response to

this, U.S. EPA completed additional investigations and planning, culminating in an Amended Record of Decision for OU2 in 2015 and Remedial Design in 2016.

The remedy for OU2 groundwater is organized based on definition of four “Contaminated Media Zones”, which are defined based on levels of contamination. From most-contaminated to least-contaminated, the four Contaminated Media Zones are the Source Area (SA), Highly Adsorbed Phase Area (HAPA), High Concentration Plume (HCP), and Dilute Plume. The remedy identifies a suite of remediation technologies which may be applied individually or in combination depending on the physical location and remedy implementation phase: steam-enhanced extraction (SEE) (note that other thermal enhancement approaches may also be used), in-situ enhanced biodegradation (ISEB), surfactant-enhanced aquifer remediation (SEAR), and in-situ chemical oxidation (ISCO). The Final Remedial Design Document (Versar, 2016) defines four phases for remedy implementation:

- Phase 1 - SEE in the Source Area.
- Phase 2 - SEAR, ISCO, and/or ISEB in the HAPA. The ISEB/SEAR/ISCO technologies can also be used to polish and treat remaining hotspots in the Source Area after completion of SEE.
- Phase 3 - ISEB in the High Concentration Plume and as a polishing step in the SA and HAPA.
- Phase 4 – MNA in all areas.

### **Summary of Conceptual Site Model**

Historical site operations at ETC involved releases of wood-treating chemicals/wastes through spills, waste piles, contaminated storm water runoff, and most prominently – the unlined surface impoundment defined by the SWMU 10 location. These releases led to significant impacts to vadose zone soils and groundwater, particularly in the SWMU 10 area. Most of the contaminated vadose zone soils have been excavated and placed into the OU1 on-site waste containment cell; although some vadose zone contamination may remain in areas that have historically been inaccessible for excavation (i.e. near the sheet pile wall). Significant quantities of aquifer soils remain impacted by NAPLs, and contaminated groundwater from the SA migrates off-site in an easterly direction. There is also a vertical component to contaminated groundwater transport, in that the depth to the top of the groundwater plume increases as groundwater flows to the east.

The anaerobic conditions that are observed within the plume suggests there is some (bio)degradation occurring within the impacted zones. Naphthalene, and possibly acenaphthene, are susceptible to enhanced biodegradation under sulfate reducing conditions in addition to aerobic degradation. The degree to which natural degradation, along with dispersion, would represent an assimilative capacity capable of stabilizing and shrinking the plume following the aggressive source area and high concentration area treatment and a reduction in mass discharge is not known but may be significant.

A primary aspect of the CSM needing to be clarified is the potential impact to the size and orientation of the SA and HAPA due to recent events; most significantly the OU1 contaminated soil excavations circa 2009 and a significant flooding event that occurred in spring 2014.

### **Summary of Findings**

The USACE evaluation team agrees with the overall remedial approach that has been developed by U.S. EPA. The emphasis on aggressive in-situ treatment technologies in the source areas should remove principal threat wastes that are currently providing a source of contaminants that impact both on-site and downgradient groundwater. By addressing these principal threat wastes first, flux of contaminants into the off-site groundwater should be significantly reduced, which will aid in effective remediation of downgradient groundwater contamination in the future.

The remedial technologies that are proposed for the SA and HAPA are generally proven technologies that have demonstrated effectiveness at other sites with similar contaminants and site conditions. Specific findings related to the OU2 remedial technologies include:

- Some site conditions may create challenges that would be favorable to a remedial approach that uses SEE in combination with other in-situ thermal treatment technologies. In particular, aquifer hydraulic conductivities, and overburden thickness are on the lower end of what is typically optimal for SEE implementation.
- Some of the anticipated remedial technology objectives and performance monitoring requirements for the Phase 1 SEE remedial action could be adjusted to provide greater flexibility for a remedial action contractor, particularly if a performance-based contracting approach can be used.
- Surfactant flushing (the SEAR technology) is primarily a mobilization technology. In all, there are a number of reasons to avoid the use of surfactant flushing, including risk of incomplete capture of mobilized contaminants, addition of extra carbon sources that would challenge bioremediation capacity, and compatibility of surfactants with other conditions generated during remediation.
- The application of ISCO at the site must include the use of a persistent oxidant to allow the dispersion and diffusion of the oxidizer through the heterogeneous aquifer materials. Persulfate is a persistent oxidant that can be activated by heat, such as will be present following in-situ thermal treatment. The oxidant demand will be substantial and leveraging the oxidant with other synergistic processes should be considered to allow further polishing of residual contaminant mass. In addition, the reaction with persulfate generates ample sulfate ions that would be an appropriate electron acceptor for the degradation of high concentrations of naphthalene. A source of additional sulfate may increase degradation, both in the direct delivery area, and downgradient through advective transport (into the areas of the plume with lower concentrations). Injection of persulfate would need to be planned to avoid impacts to the nearby Agrico Superfund site; however if applied at appropriate levels and only in highly contaminated areas, sulfate would not be expected to propagate too far downgradient.
- The Final Remedial Design currently indicates that remediation of the HAPA under Phase 2 will occur in a distinct operational phase separate from the Phase I remediation of the SA. Some scheduling efficiencies and potential synergies between the Phase 1 and Phase 2 remediation technologies could be gained by allowing the remedial action contractor to possibly implement portions of the Phase 1 and Phase 2 remedies simultaneously or with some schedule overlap. In particular, as discussed above, some of the potential ISCO and ISEB technology applications that could be performed in the HAPA could benefit from the applied heat that will be introduced into the subsurface while remediating the SA.
- The Final Remedial Design does a good job of identifying the majority of the design characterization activities that will be needed for remedy implementation in the SA and HAPA areas. USACE agrees with the strategy of requiring the selected remedial action contractor to complete these design characterization activities; design of bench and pilot-scale studies is often dependent on the specific remedy implementation strategies that a remedial action contractor uses. USACE believes that potential bidders will have sufficient information to be relatively comfortable with developing a bid for the remedial technologies specified for Phase 1 and Phase 2, based on the previously completed design characterization activities combined with the ample amount of industry experience at similar wood treating sites.



- Design characterization work that is performed prior to selecting a remedial action contractor should focus on narrowing down the uncertainty associated with the size of the SA and HAPA areas both due to potential changes in site conditions following completion of the investigation work in 2013 and data gaps from the previous investigation work. Completing additional characterization to refine the sizes of the SA and HAPA prior to bidding the remedial action contract should lead to more competitive bids (less factor-of-safety costs) and less variability in assumptions between different bidders.

## **Summary of Recommendations**

### Recommendations to Address Design Characterization Needs:

- Complete a subsurface soil/groundwater investigation to refine the horizontal and vertical limits of the SA and HAPA zones.
- Install additional monitoring wells downgradient of the eastern boundary of the site to address a gap in monitoring well coverage downgradient of the site boundary.
- In the area east of the SWMU 10 boundary, collect additional soil/groundwater samples to assess if the current definition of the HAPA is representative of conditions in this area.
- Complete a pump test near SWMU 10 to confirm site-specific aquifer hydraulic conductivity, which will be important data for bidding and designing both the in-situ thermal and SEAR/ISCO/ISEB remedy components.
- Install additional monitoring wells upgradient of SWMU 10 to supplement the existing upgradient monitoring well network.
- Continue to complete periodic groundwater monitoring events of select ETC wells. The focus of continued groundwater monitoring events should be sampling wells closer to the ETC site, since these monitoring wells will provide data that will affect remedy implementation and performance monitoring in the SA and HAPA. A representative set of downgradient monitoring wells should also be included in further monitoring events.

### Recommendations Related to Technology Assessment for SA and HAPA Remedy:

- Encourage bidders and the selected remedial action contractor to consider remedial strategies that use other in-situ thermal technologies or use SEE in combination with the other in-situ thermal technologies. Providing flexibility to allow application of thermal treatment beyond the SA and into the HAPA may also allow a more cost-effective and certain remedy.
- Consider revising or supplementing the performance objectives/remedial technology objectives for the Phase 1 remedy in the SA to provide more implementation flexibility for the RA contractor. Supplemental objectives may include achieving an asymptotic contaminant mass removal rate, and/or attaining and maintaining a minimum subsurface temperature at specified temperature monitoring points.
- Plan the sequencing and timing of Phase 1 and Phase 2 activities to take advantage of the synergies of the heating and in-situ chemical oxidation and bioremediation.

### Recommendations for a Remedial Design/Remedial Action Delivery Strategy:

USACE's understanding of the site conditions, selected remedy, and remedial design indicates that there are five major stages to implementation of the remedy in the SA and HAPA areas (excluding bidding/contracting):

1. Pre-remedial characterization/baseline sampling
2. Major site civil preparations
3. Pre-remedial treatability testing (bench and pilot-scale)
4. Remedy implementation
5. Post-remedial performance monitoring

Separating these five stages into two distinct contract actions appears to be a remedial design/remedial action delivery strategy that will present the best opportunity for technical success and cost savings.

Under this recommended approach, the first contract action would include the pre-remedial characterization/baseline sampling and major site civil preparations. The second contract action would occur after completion of the first contract action and include the remaining three stages of treatability testing, remedy implementation, and post-remedial performance monitoring.

#### Other Recommendations:

- Encourage contractors to consider green/sustainable cleanup practices when planning and implementing the remedy. Green/sustainable cleanup practices can be encouraged in open-ended ways through contract incentives or can be required in more specific ways (such as requiring contractors to complete best management practice (BMP) checklists.
- If possible, setup utility services (natural gas, water, electricity) such that those services are paid directly by U.S. EPA. This can avoid the markup that is associated with RA contractors paying for these services.

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## PREFACE

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This report was prepared by the US Army Corps of Engineers (USACE) to support the U.S. Environmental Protection Agency, which is leading cleanup activities at the Escambia Wood Treating Superfund Site. The project contacts are as follows:

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## LIST OF ACRONYMS

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AROD	Amended Record of Decision
bgs	Below ground surface
bls	Below land surface
BMP	Best Management Practice
cm/sec	Centimeters per second
COC	Contaminant of Concern
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid
DPT	Direct Push Technology
ERH	Electrical Resistance Heating
ETC	Escambia Wood Treating Company
FDEP	Florida Department of Environmental Protection
FS	Feasibility Study
g/cc	Grams per cubic centimeter
HAPA	Highly Adsorbed Phase Area
HCP	High Concentration Plume
ISCO	In-Site Chemical Oxidation
ISEB	In-Situ Enhanced Biodegradation
LPZ	Low Permeability Zone
mg/kg	Milligrams per Kilogram
MK	Mann-Kendall
MNA	Monitored Natural Attenuation
MPZ	Main Producing Zone
NADC	Natural Attenuation Default Concentration
NAPL	Non-Aqueous Phase Liquid
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PC	Pensacola Clay
PCP	Pentachlorophenol
PV	Pore Volume
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
ROD	Record of Decision
SA	Source Area
SEAR	Surfactant Enhanced Aquifer Remediation
SEE	Steam Enhanced Extraction

SMWU	Solid Waste Management Unit
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
SZ	Surficial Zone
Tar-GOST	Tar-Specific Green Optical Screening Tool
TCH	Thermocouple Heating
U.S. EPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
Vb	Bulk volume
VOC	Volatile Organic Compound
µg/kg	Micrograms per kilogram
µg/L	Micrograms per Liter

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### **Attachments**

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Attachment B	- Groundwater Data Review Information
Attachment C	- Literature Review of PAH and PCP Degradation
Attachment D	- Focused Feasibility Study Cost Estimate Review

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## 1.0 INTRODUCTION

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### 1.1 PURPOSE

This Technical Memorandum presents technical and budgetary recommendations for pending remedial actions for Operable Unit 2 (OU2) – Groundwater at the Escambia Wood Treating (ETC) Superfund Site in Pensacola, Florida. Specifically, the U.S. Environmental Protection Agency (EPA) has tasked the US Army Corps of Engineers with providing recommendations related to the following elements:

- Design characterization needs to support design and implementation of the Source Area (SA) and Highly Absorbed Phase Area (HAPA) components of the remedy;
- Technology Assessment for SA and HAPA components of the selected remedy;
- Remedial Design/Remedial Action Delivery Strategy for all components of the selected remedy considering remedial action funding limitations

The recommendations included in this Technical Memorandum are intended to help the site team identify delivery strategies and opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation and represent the opinions of the evaluation team. These recommendations do not constitute requirements for future action, but rather are provided for consideration by the EPA. Also note that while the recommendations may provide some details to consider during implementation, the recommendations are not meant to replace other, more comprehensive, planning documents such as work plans, sampling plans, and quality assurance project plans.

### 1.2 TEAM COMPOSITION

The evaluation team consisted of the following individuals from the US Army Corps of Engineers (USACE) Environmental and Munitions Center of Expertise (EM CX) and Mobile District:

**Table 1.1 Optimization Team Composition**

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### 1.3 DOCUMENTS REVIEWED

The following documents were reviewed. The reader is directed to these documents for additional site information that is not provided in this report. Additional information was provided by U.S. EPA Region 4 in the form of electronic data, site specific investigation data, etc.

Black & Veatch (B&V), 2009, Final Basis of Design Report Escambia Wood Treating Company OU2, September.

B&V, 2010, Technical Memorandum Escambia Wood Treating Company Site, Discussion of SWMU 10 Data and Potential NAPL Remedial Technologies, July.

B&V, 2014, Focus Feasibility Study Escambia Wood Treating Company Site Operable Unit 2 Solid Waste Management Unit 10, July.

CDM Federal Programs Corporation, 2005, Draft Final Remedial Investigation Report for the Escambia Treating Company Site Operable Unit 2, June.

Seneca J2 Environmental Joint Venture, 2015, Completion Report Erosion Repair Activities Escambia Treating Company Superfund Site, July.

U.S. Army Corps of Engineers, 2014, EM 200-1-21 Design: In Situ Thermal Remediation, May.

U.S. EPA, 2009, Groundwater Issue: Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites, EPA/600/R-09/119, September.

U.S. EPA, 2009, Direct Final Notice of Deletion of the Southern California Edison, Visalia Pole Yard Superfund Site from the National Priorities List, July.

U.S. EPA Region 4, 2010, Interim Remedial Action Report, Escambia Wood Treating Company Operable Unit 1 Soils, September.

U.S. EPA Office of Solid Waste and Emergency Response, 2012, Green Remediation Best Management Practices: Implementing In Situ Thermal Technologies, October.

U.S. EPA Region 4, 2015, Groundwater Level Measurements After Flood Event Escambia Wood Treating Superfund Site area, March.

U.S. EPA Region 4, 2015, Amended Record of Decision Summary of Remedial Alternative Selection Escambia Wood Treating Company Superfund Site Operable Unit 2 (Groundwater), September.

U.S. EPA Region 4, 2017, Fourth Five-year Review Report for Escambia Wood – Pensacola Superfund Site, September.

U.S. EPA Region 4, 2018, Annual Groundwater Sampling Investigation for Evaluation of the OU Remedy Escambia Wood Treating Superfund Site Area, January.

Versar, 2016, Final Remedial Design for Operable Unit 2 Escambia Wood Treating Company Superfund Site, September.

## **1.4 QUALITY ASSURANCE**

This evaluation utilizes existing environmental data to interpret the CSM, evaluate remedy design, and make recommendations to best implement the remedy. The quality of the existing data is evaluated by the

optimization team prior to using the data for these purposes. The evaluation for data quality includes a brief review of how the data were collected and managed (where practical, the site Quality Assurance Project Plan [QAPP] is considered), the consistency of the data with other site data, and the use of the data in the evaluation. Data that are of suspect quality are either not used as part of the optimization evaluation or are used with the quality concerns noted. Where appropriate, this report provides recommendations made to improve data quality.

## **1.5 PERSONS CONTACTED**

The following individuals associated with the site were contacted during the Optimization Evaluation:

**Table 1.2 Persons Contacted during Optimization Evaluation**

<b>Name</b>	<b>Affiliation</b>	<b>Phone</b>	<b>Email Address</b>
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## 2.0 SITE BACKGROUND

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### 2.1 LOCATION

The ETC site is located in Pensacola, Escambia County, Florida at 3910 North Palafox Street. The site is located approximately 0.3 miles west of Interstate 110, and is accessed via N Palafox Street, which forms the southwest border of the site. Further location information is summarized on **Figure 1**, and a photolog from a recent USACE site visit is included in **Attachment A**.

### 2.2 SITE HISTORY

#### 2.2.1 HISTORIC LAND USE AND OPERATIONS

The ETC site was used for manufacturing treated wood products beginning in 1942 (EPA, 2015). Wood products such as telephone poles and pilings were treated with preservatives (creosote and pentachlorophenol [PCP]) to provide protection against wood-destroying insects and wood-rotting fungi. A description of structures that were historically present at the ETC site comes from the 2005 Remedial Investigation Report: “*Structures remaining at the facility after its closure included three open surface impoundments, ... Two of the impoundments were used as recirculation ponds for condenser water and to receive condensate water from an oil/water separator... A backfilled surface impoundment, reportedly used during the 1950s and 1960s, was located in the northeast portion of the facility. The impoundment, which covered 1.5 acres, was backfilled with native soil sometime in the early 1960s. In addition to the impoundments, the site consisted of a process area (containing preservative tanks and treatment cylinders), a bark-fired boiler, a pole mill, an office building, a laboratory...*” (CDM, 2005).

Manufacturing activities at the site ceased in 1982, and the owners abandoned the site in 1991.

The ETC site is currently undeveloped and includes a closed contaminated soil containment cell (OU1), soil borrow pit, and an open excavation area that is referred to as Solid Waste Management Unit (SWMU) 10, which is the location of the former surface impoundment reportedly used in the 1950s and 1960s. Site features focused around SWMU 10 are shown on **Figure 2**. Surrounding land use is primarily commercial/light industrial to the north, west, and south. Railroad tracks operated by CSX are present along the eastern border of the ETC site. Very recently, portions of the ETC site have been used for temporary storage/management of vegetative debris gathered from the community following Hurricane Sally in September 2020; storage and management of this debris concluded in January/February 2021.

#### 2.2.2 CHRONOLOGY OF ENFORCEMENT AND REMEDIAL ACTIVITIES

Enforcement and remedial activities at the ETC site have been organized through designation of two OUs: OU1 – Source Control and OU-2 – Groundwater. A detailed history of the numerous enforcement and remedial activities that have taken place at the ETC site can be found in other site documents. A brief summary of major enforcement and remedial activities is included below:

- The owners/operators of the ETC facility conducted partial removal/cleanup actions in 1985 and 1988 to remove sludges and contaminated wooden sidewalls from three surface impoundments present at the time. As previously noted, the owners/operators abandoned the site in 1991.

- EPA conducted an extensive excavation/demolition activity between 1991 and 1992. Approximately 255,000 cubic yards of contaminated soils were placed into a lined and high-density polyethylene-capped stockpile located on-site. Contaminated soils located at SWMU 10 (the former unlined surface impoundment) were excavated to approximately 40 feet below ground surface and included in the 255,000 cubic yards of contaminated soils placed into the lined/capped stockpile.
- A Remedial Investigation was completed for OU2 in 2005 (CDM, 2005), a Feasibility Study was completed in 2008 (Black & Veatch, 2008), and a remedy was selected for OU2 in a 2008 Record of Decision (EPA, 2008).
- The OU1 final remedial action construction began in October 2007 and was substantially complete in June 2010. A new on-site containment cell was constructed to contain the previously-excavated contaminated soils (1991-1992 removal action) along with additional contaminated soils excavated from the site. In addition to the contaminated soil remediation, population relocation was also completed as part of the OU1 response to move affected residents located near the ETC site.
- While implementing the remedial action for OU1, additional contaminated soils were excavated from the SWMU 10 area to approximately five feet below the water table (Versar, 2016). While completing this excavation work, the extent of contamination at SWMU 10 was determined to be much greater than what was previously known. This finding led to additional investigation work which ultimately indicated that the remedy selected for ETC-impacted groundwater in the 2008 ROD was not adequate for the level of contamination at OU2.
- Additional investigations were performed between 2007 and 2013 to better define the extent of contamination associated with the SWMU 10 area. Based on the findings of these investigations, a Focused Feasibility Study (Black & Veatch, 2014) and Amended Record of Decision (EPA, 2015) were prepared.
- A significant flooding event occurred at SWMU 10 in 2014; although not an enforcement/remedial activity, this event warrants some discussion here. In April 2014, the ETC site and surrounding area received nearly two feet of rain in roughly one day. This caused the stormwater impoundment located immediately to the north of SWMU 10 to overtop and breach. The overtop/breach directed stormwater and sediment into SWMU 10 and also damaged the sheet-pile retaining wall located on the north side of the SWMU 10 excavation. Water remained ponded in the excavation for an extended time. The eroded embankment of the stormwater impoundment was repaired in 2015; the damage to the SWMU 10 sheet pile wall was not able to be repaired, and the sheet pile wall remains erect but bowed inward.

## 2.3 POTENTIAL HUMAN AND ECOLOGICAL RECEPTORS

The OU2 remedy is for impacted groundwater, and the following potential human exposure pathways were identified in the Focused Feasibility Study (2014): ingestion of groundwater and inhalation of volatiles released during showering. These potential exposure routes are associated with possible future installation of residential water supply wells. Currently, there is no known use of groundwater as a potable water source in the OU2 groundwater plume; drinking water is supplied by a public water source that is not impacted by the site (U.S. EPA, 2015). Although the groundwater plume extends off-site underneath residential areas to the east, the contaminated groundwater plume in these residential areas is located approximately 30 feet or deeper below the top of the water table, based on sampling of well clusters installed at different depths in the aquifer. Shallow groundwater samples collected in downgradient areas have generally not had detections of site COCs. Based on this, vapor intrusion has been excluded from consideration as a potential exposure pathway.



There are no current or potential ecological receptor exposure routes. As discussed in **Section 3.4**, no site COCs have been detected in Bayou Texar, the major ecological feature of concern located downgradient of the ETC site.

## 2.4 DESCRIPTION OF SELECTED REMEDY

### 2.4.1 REMEDIAL ACTION OBJECTIVES AND CLEANUP GOALS

The remedial action objectives (RAOs) established in the Record of Decision (2008) and Amended Record of Decision (2015) are:

- Prevent further contamination of groundwater by aggressive treatment of the source area and principal threat wastes.
- Prevent future human exposure to contaminated groundwater by treating the aquifer to meet health-based cleanup standards.
- Eliminate the potential for the future degradation of natural resources (Bayou Texar) from site-related contaminants.
- Restore groundwater to its beneficial use, which is drinking water.

COCs and cleanup goals for the ETC site groundwater were also defined in the Record of Decision (2008) and updated in the Amended Record of Decision (2015). There are 18 COCs, classified as either volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs). In addition to cleanup goals, U.S. EPA has also identified the Florida Department of Environmental Protection's (FDEP) Natural Attenuation Default Concentrations (NADCs), which are groundwater concentrations that may be used to inform when active groundwater remediation can transition to monitored natural attenuation (MNA). The ETC site COCs, cleanup goals, and NADCs are provided in **Table 2-1**.

**Table 2.1 - Groundwater COCs, Cleanup Levels, and NADCs**

COC	AROD Cleanup Level (µg/L)	FDEP NADC (µg/L)
1,1-Biphenyl	350	-
1,2,4-Trimethylbenzene	350	-
1,3,5-Trimethylbenzene	350	-
1-Methylnaphthalene	28	280
2-Methylnaphthalene	10	280
2,4-Dimethylphenol	140	1,400
3- and/or 4-Methylphenol	3.5	35
Acenaphthene	420	-
Benzene	1	100
Benzo(a)pyrene	0.2	20
Carbazole	1.8	180
Dibenzofuran	28	280
Fluorene	280	2,800
Naphthalene	10	140
Nitrobenzene	3.5	35
Pentachlorophenol	1	100

COC	AROD Cleanup Level (µg/L)	FDEP NADC (µg/L)
Phenanthrene	210	2,100
Phenol	2,100	-

Notes: µg/L = micrograms per liter, AROD = Amended Record of Decision, COC = Contaminant of Concern, FDEP = Florida Department of Environmental Protection, NADC = Natural Attenuation Default Concentration  
Table adapted from Final Remedial Design (Versar, 2016)

## 2.4.2 REMEDIAL ACTION COMPONENTS

A summary of the selected remedy for OU2 groundwater is provided below. A full description of the remedy is included in the Amended Record of Decision (EPA, 2015). The remedy is organized based on definition of four “Contaminated Media Zones” in the ETC conceptual site model (CSM), which are defined based on levels of contamination. The four Contaminated Media Zones are the:

- Source Area (SA): Soils that are heavily stained and contain either mobile free-flowing NAPL or non-mobile NAPL.
- Highly Adsorbed Phase Area (HAPA): Soils stained with non-mobile NAPL and groundwater with naphthalene concentrations above 7,000 micrograms per liter (µg/L)
- High Concentration Plume (HCP): Aquifer with groundwater naphthalene concentrations less than 7,000 µg/L but greater than 140 µg/L (the naphthalene NADC).
- Dilute Plume: Aquifer with groundwater naphthalene concentrations less than the NADC level of 140 µg/L

The boundaries of these four areas – as they were defined in the Amended Record of Decision (EPA, 2015) are shown on **Figure 3**. The selected remedy identifies a suite of remediation technologies which may be applied individually or in combination depending on the physical location and remedy implementation phase: steam-enhanced extraction (SEE) (note that the AROD provides for consideration of other approaches to thermal enhancement), in-situ enhanced biodegradation (ISEB), surfactant-enhanced aquifer remediation (SEAR), and in-situ chemical oxidation (ISCO). The Final Remedial Design Document (Versar, 2016) defines four phases for remedy implementation:

- Phase 1 - SEE in the Source Area.
- Phase 2 - SEAR, ISCO, and/or ISEB in the HAPA. The ISEB/SEAR/ISCO technologies can also be used to polish and treat remaining hotspots in the Source Area after completion of SEE.
- Phase 3 - ISEB in the High Concentration Plume and as a polishing step in the SA and HAPA.
- Phase 4 – MNA in all areas.

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## **3.0 EXISTING DATA AND INFORMATION**

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### **3.1 GEOLOGY SETTING AND HYDROGEOLOGY**

The site is located in the Coastal Plain physiographic province. The province is characterized by unconsolidated soils deposited as marine terraces and alluvial sequences. In the Pensacola area, the near-surface materials are heterogeneous alluvium and terrace deposits that are Pleistocene or younger in age and rest on Pliocene-age sandy sediments of the Citronelle Formation. These sandy materials are water-bearing. The Pensacola Clay underlies the Citronelle Formation. The Miocene-age clays and sandy clays of the Pensacola Clay act as an effective aquitard. The regionally extensive limestone of the Floridan Aquifer underlies the Pensacola Clay.

The hydrogeology at the site includes multiple water-bearing units within the surficial alluvial deposits and the Citronelle Formation that have been included as the “Sand and Gravel Aquifer.” The Pensacola Clay aquitard underlies the Sand and Gravel Aquifer. This unit has been divided into the following general strata, from the surface downward: 1) the Surficial Zone, 2) the Low Permeability Zone, and 3) the Main Producing Zone.

The unconfined aquifer of the Surficial Zone is composed of approximately 70 feet of saturated fine to medium poorly graded sands with some silty and clayey sand units encountered. The thickness of these heterogeneous sediments declines eastward toward Bayou Texar. The water table is encountered at depths of 30-50 feet below natural grade at the site and groundwater flows generally to the east toward Bayou Texar under a typical gradient of 0.002-0.004 feet/foot at rates estimated in the Remedial Investigation at approximately 0.13 feet/day. Hydraulic conductivities have been determined by slug testing to be on the order of 10-15 feet/day.

The Low Permeability Zone is comprised of 60-85 feet of heterogeneous, well graded, silty and clayey sand/sandy clay with some silt and clay. The thickness declines toward the east of the site. This unit impedes but does not prevent vertical flow from the Surficial Zone to the deeper Main Producing Zone in much of the western study area. There is both lateral and vertical flow through this unit, and slug testing (as described in the Remedial Investigation) has indicated a range of hydraulic conductivities of 0.07 to 43 feet/day with a geometric average of approximately 3 feet/day.

At the site, the Main Producing Zone includes approximately 30 feet of permeable sands and gravels located between the Low Permeability Zone and the underlying Pensacola Clay. This unit is a leaky confined aquifer and yields ample groundwater. Hydraulic conductivities of the unit are in the range of 3 to 50 feet/day. Groundwater flow in this aquifer near the site is generally toward the east under a gradient of 0.005 to 0.009 feet/foot at a velocity estimated in the Remedial Investigation to be approximately 0.3 feet/day.

### **3.2 SOIL CONTAMINATION**

Because the OU2 remedy is for groundwater contamination, and soil contamination was previously addressed under the OU1 remedy, the assessment of soil contamination in this Technical Memorandum is limited to soil contamination information which may have an impact on implementation/performance of the OU2 remedy. The OU1 soil remedy included cleanup levels based on both direct exposure and protection of groundwater due to leaching from soil. While the OU1 remedy is complete, there are vadose

zone soils around SWMU 10 that exceeded OU1 cleanup levels at the time of completion. In particular, the sheet pile wall on the north side of SWMU 10 prevented excavation of some vadose zone soils (additional details included at the end of this section). This Technical Memorandum does not present a complete picture of past and present soil contamination at the ETC site.

The 2010 Technical Memorandum (Black & Veatch, 2010) provides most of the available information regarding soil contamination in the vadose zone near SWMU 10, including soil samples collected from 52 direct push borings. The highest naphthalene concentrations in vadose zone/capillary fringe soils were observed at location DPT06 (1,100 mg/kg at 5-10 feet bgs), DPT05 (650 mg/kg at 20-25 feet bgs), DPT08 (410 mg/kg at 40-45 feet bgs), and DPT19 (660 mg/kg at 35-40 feet bgs). One interesting pentachlorophenol result was observed at DPT12, where concentrations between 56 – 87 mg/kg were observed at 0-10 feet bgs even though no naphthalene was detected in the same intervals.

Given that additional contaminated soils were excavated from SWMU 10 during the OU1 remedial action, it is very possible that some of the locations noted above with high naphthalene concentrations were excavated and placed into the OU1 containment cell. The 2010 Technical Memorandum (Black & Veatch, 2010) indicates: “*Contaminated soil above the water table within and surrounding SWMU 10 was excavated and placed into the onsite, lined and capped, subsurface containment cell. The excavations within SWMU 10 were extended to a depth of about 5 feet below the water table to excavate the NAPL impacted soil to the extent readily accessible with standard soil excavation techniques.*” It is slightly more difficult to determine if soils with high naphthalene concentrations were excavated in the areas that are located along the current side slopes of the SWMU 10 excavation (i.e. borings DPT05 and DPT08). Based on the depths that high naphthalene concentrations were observed at these two locations, the naphthalene results may actually represent soils collected below the groundwater table.

TarGOST profiles were completed during two investigation events in December 2008 and March 2013 to delineate depth and areal coverage of contamination in soil/groundwater within and around SWMU 10. The TarGOST profiles do not seem to show evidence of significant vadose zone soil contamination in/around SWMU 10. Within the SWMU 10 excavation, several locations where TarGOST profiles were completed (RDCPT09, TG27, TG29, TG30, TG43, TG49, and TG51) showed evidence of shallow contamination. Depending on the depth of ground surface when TarGOST borings were completed, this contamination could either indicate vadose zone soil contamination or heavily-impacted soils at/below the water table.

According to the OU1 Interim Remedial Action Report (U.S. EPA, 2010), “... *a pocket of contaminated soil near SWMU-10 located at water level and behind existing sheet pile wall was left for the OU2 remedy.*” That same document also indicates “*In order to avoid removal of the existing sheet piling, the contaminated soil immediately south of the sheet pile wall ... were left in-place to be handled with the future OU2 remediation.*” Because the sheet pile wall prevented access during the OU1 remedy implementation the exact locations, depths, and concentrations of contaminated soils that remained in SWMU 10 following the OU1 excavation activity are not known precisely. However, completion of TarGOST and direct push borings on the north side of the sheet pile wall aided in defining the extent of soil contamination in the vadose zone and upper water table. Based on these borings, the lateral and vertical extent of soil contamination north of the sheet pile wall was fairly limited in size.

### **3.3 GROUNDWATER CONTAMINATION**

#### **3.3.1 NAPHTHALENE TRENDS**

To assess trends in naphthalene concentrations, groundwater data for samples collected from 84 different wells from 2007 – 2017 was assessed using Mann-Kendall trend analysis. A complete report and table of the Mann-Kendall analysis is included in **Attachment B**. The vast majority of monitoring wells did not have an increasing/decreasing trend (using a 95% confidence level). Six wells had a decreasing trend and five wells had an increasing trend as shown in **Table 3-1**. See **Figure B-5** and **Figure B-6** in **Attachment B** for time-series graphs.

For monitoring wells AC02D, AC29D, NWD4D, and PMWC049 the decreasing trends can't be attributed to any obvious causes. AC02D, AC29D, and PMWC049 appear to be located cross-gradient (southeast) of SWMU 10 but would have been located closer to the aboveground removal action stockpile of contaminated soil which was relocated at the ETC site around 2010. It could be possible that the OU1 remedial action resulted in decreased flux of contaminants into groundwater (either through an improved liner system in the new containment unit or through removal of additional contaminated soils below the old liner system during construction of the new containment unit). The trend in NWD4D could possibly be attributed to a combination of additional contaminated soil removal during the OU1 remedial activities plus the oxygen injection pilot study which both occurred upgradient of NWD4D circa 2010 (see **Section 4.3.1** for details), or a subtle change in the groundwater flow direction that slightly shifted the plume. The decreasing trend in NWD4D is notable given that this monitoring well is one of the furthest downgradient monitoring wells which has historically had significant naphthalene detections in the Main Producing Zone vertical interval. However, given recent increasing concentration trends in other Main Producing Zone monitoring wells that are located upgradient of NWD4D, it may be reasonable to expect a rebound in concentrations in NWD4D in future sampling events.

The decreasing trends in HW2PMWB71 and HW2PMWC55 appear to be directly related to the oxygen injection pilot study which was performed circa 2010. Trend charts show a clear reduction in naphthalene concentrations between 2009 and 2011; however, concentration rebound was observed in both monitoring wells (and HW2PMWA91) in more recent samples.

The increasing naphthalene trends in MW26D, MW28D, and MW30D don't appear to have an obvious explanation. The level of increase is most notable in MW28D, which reached a maximum concentration of 9,700 µg/L in November 2015; however because this well wasn't installed until 2010, older data isn't available to assess possible rebound effect from after the oxygen injection pilot study which occurred near this well. It's also possible that the 2014 flooding event contributed to the increasing trends given the spike in concentration between November 2014 and November 2015. MW21C and MW30D saw similar increases after November 2014, but at much lower levels than MW28D. The increasing naphthalene trend that was calculated in HW3PMWB71 appears to also be explained by the post pilot study rebound; naphthalene concentrations in recent years have been similar to pre-pilot study levels. Another possible explanation of the increasing trend in HW3PMWB71 could be a preferential groundwater flow path in the horizontal well casing, which has been posited by U.S. EPA.

Naphthalene groundwater results were also reviewed with an emphasis on samples collected from immediately before/after the 2014 flooding event. Because there is a limited number of samples collected in this time period, formal trend analysis was considered less useful; visual assessments of time-series charts were completed instead. Time series charts are included as **Figure B-1** through **Figure B-4** in **Attachment B**.

- Surficial Zone monitoring wells near SWMU 10 did not show a significant/sustained change following the flood event. An exception to this is cross-gradient/upgradient monitoring well CCPMW-002, which is part of the OU1 monitoring well network. Naphthalene concentrations increased from 28 µg/L in 2013 to 1,300 µg/L in 2014 following the flood. Concentrations

decreased to non-detect levels by 2016. There was a significant water table elevation increase correlated with this naphthalene concentration increase.

- Low Permeability Zone monitoring wells MW07I and PMWA110 both had significant naphthalene concentration increases (nearly doubling) between March 2014 and November 2015. However, these wells have fluctuated significantly in the past, possibly due to the high naphthalene concentrations near 50% of solubility.
- Main Producing Zone monitoring wells MW28D, MW29D, and MW14D had significant naphthalene increases after the 2014 flood event. MW32-147 also has elevated (10,000 µg/L) naphthalene levels but was not sampled prior to the 2014 flood. It should be noted that although the naphthalene analytical results in MW32-147 have been unusually consistent, there is no reason to assume issues with the data. Other COCs detected in MW32-147 have shown typical levels of variability, and the proportional levels of COCs in MW32-147 are consistent with other ETC site wells.
- For the monitoring wells in the Pensacola Clay layer, a significant naphthalene concentration increase was observed in MW21C and MW22D following the 2014 flood. Monitoring wells located further downgradient (MW16I and MW23I) did not show appreciable changes following the flood.

**Table 3.1 – Naphthalene Mann-Kendall Trend Analysis**

Well Name	Aquifer Zone	Distance from SWMU10 (ft)	Number Values Reported (n)	Minimum Naphthalene Concentration (ug/L)	Maximum Naphthalene Concentration (ug/L)	Mean Naphthalene Concentration (ug/L)	MK Test Value (S)	Trend
AC02D	MPZ	2,856	13	2.0	870.0	288.0	-39.0	Decreasing
AC29D	PC	5,801	10	1.0	47.0	7.5	-27.0	Decreasing
HW2PMWB71	SZ	454	18	710.0	15,000.0	5,751.0	-65.0	Decreasing
HW2PMWC55	SZ	457	18	0.8	670.0	176.7	-37.0	Decreasing
NWD4D	MPZ	5,457	10	6.6	2,500.0	550.2	-38.0	Decreasing
PMWC049	SZ	224	12	2.1	2,200.0	439.3	-35.0	Decreasing
HW3PMWB71	SZ	602	19	1.0	8,800.0	2,129.0	53.0	Increasing
MW21C	PC	4,128	17	0.8	1,800.0	783.7	79.0	Increasing
MW26D*	MPZ	8,562	8	0.5	2.0	1.3	18.0	Increasing
MW28D	MPZ	1,756	11	2,200.0	9,700.0	5,927.0	43.0	Increasing
MW30D	MPZ	4,433	14	0.1	1,100.0	209.4	83.0	Increasing

Notes: Trend analysis completed with ProUCL V5.1, 95% Confidence Coefficient

MK = Mann-Kendall

ug/L = micrograms per liter

Decreasing = statistically significant evidence of a decreasing trend at the specified level of significance

Increasing = statistically significant evidence of an increasing trend at the specified level of significance

LPZ = Low Permeability Zone, MPZ = Main Producing Zone, PC = Pensacola Clay, SZ = Surficial Zone

\*The trend for MW26D does not appear to be meaningful given the low naphthalene concentrations.

### 3.3.2 COC ASSESSMENT

**Table 2-1** lists all 18 COCs that have been designated for OU2 groundwater. The Amended Record of Decision (EPA, 2015) and Final Remedial Design (Versar, 2016) focus on naphthalene as the most significant COC for OU2 based on its frequent high detections above the groundwater cleanup levels and extensive migration distance from the SWMU 10 source area. To verify if it is appropriate to use



naphthalene as a representative COC for groundwater contamination, groundwater data was assessed in terms of the proportion that each COC contributes to the overall amount of COCs detected in groundwater.

Groundwater data covering the timeframe from 2007 – 2017 was reviewed for 84 monitoring wells. For each monitoring well, the average detected concentration of each COC was calculated and compared to the sum of all average COC detections for the particular monitoring well. This calculation gave results showing what percentage each COC contributes to the overall amount of groundwater contaminants detected in a monitoring well. A table and **Figure B-9** through **Figure B-12** with the results from this exercise are included in **Attachment B**.

A summary of observations from the COC assessment is:

- Naphthalene does in fact represent a majority of the quantity of detected COCs for ETC groundwater. Particularly for monitoring wells where naphthalene exceeds the NADC concentration of 140 µg/L, naphthalene typically accounted for at least 70% of all COC detections.
- Where naphthalene did not account for a majority (>70%) of COC detections, it was typically because overall levels of COC detections were low: typically, below the groundwater cleanup levels or NADC levels.
- Other COCs that are commonly associated with creosote (carbazole, methyl naphthalene, acenaphthene, etc.) are commonly detected at concentrations greater than the groundwater cleanup levels/NADCs. These detections were nearly always in monitoring wells where naphthalene is also present and makes up the majority of COC detections.
- PCP, the other wood treating chemical used at ETC in addition to naphthalene, did not exhibit significant or widespread exceedances of the NADC level. At monitoring wells where the PCP groundwater cleanup level was exceeded, naphthalene was also usually present at much higher relative concentrations (1-3 orders of magnitude).
- The groundwater data set for benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene was very limited. Many wells have no samples for these COCs, and few samples (typically less than five) were recorded for the wells that have been sampled.

### **3.3.3 GROUNDWATER GEOCHEMISTRY**

Based on available analytical and field data, the natural water quality at the site is relatively good with total dissolved solids of only a few hundred parts per million. The Surficial Zone, where unimpacted by the site, has several parts per million dissolved oxygen. In general, the deeper groundwater is less oxidized, and within the plume, many wells particularly in the Low Permeability Zone and the Main Producing Zones have low dissolved oxygen and evidence of nitrate, iron, and sulfate reduction, though the conditions appear variable.

## **3.4 SURFACE WATER AND SEDIMENT CONTAMINATION**

Discounting man-made stormwater impoundments, the nearest downgradient surface water feature is Bayou Texar, which is located approximately 1.25 miles east-northeast of the ETC site. According to the Focused Feasibility Study (Black & Veatch, 2014), no ETC site COCs were detected in samples collected from Bayou Texar during a 2002 screening level ecological risk assessment. In discussions with U.S.

EPA for this assessment, the likelihood of increased dissolved oxygen levels in groundwater near the Bayou due to tidal fluctuations was noted, along with expected higher bioactivity rates in the Bayou sediments. Both of these factors could contribute to significant natural attenuation of ETC COCs, particularly naphthalene. Because the focus of the assessment presented in this Technical Memorandum is the highly-impacted areas in the Source Area and Highly Adsorbed Phase Area, further discussion of surface water and sediment is not considered necessary.

### 3.5 CONCEPTUAL SITE MODEL

Historical site operations at ETC involved releases of wood-treating chemicals/wastes through spills, waste piles, contaminated storm water runoff, and most prominently – the unlined surface impoundment defined by the SWMU 10 location. These releases led to significant impacts to vadose zone soils and groundwater, particularly in the SWMU 10 area. Most of the contaminated vadose zone soils have been excavated and placed into the OU1 on-site waste containment cell; although some vadose zone contamination may remain in areas that have historically been inaccessible for excavation (i.e. near the sheet pile wall). Significant quantities of aquifer soils remain impacted by NAPLs in the area defined as the SA (see **Figure 3**). Contaminated groundwater from the SA migrates off-site in an easterly direction. There is also a vertical component to contaminated groundwater transport, in that the depth to the top of the groundwater plume increases as groundwater flows to the east.

The anaerobic conditions that are observed within the plume suggests there is some (bio)degradation occurring within the impacted zones. Naphthalene, and possibly acenaphthene, are susceptible to enhanced biodegradation under sulfate reducing conditions (see **Attachment C**) in addition to aerobic degradation. The degree to which natural degradation, along with dispersion, would represent an assimilative capacity capable of stabilizing and shrinking the plume following the aggressive source area and high concentration area treatment and a reduction in mass discharge is not known but may be significant.

A primary question to be answered by the CSM is potential impacts to the size and orientation of the SA and HAPA due to recent events; most significantly the OU1 contaminated soil excavations circa 2009 and the significant flooding event that occurred in spring 2014.

#### 3.5.1 DATA GAPS

- The current size/orientation of the SA and HAPA. Some inferences can be made based on groundwater monitoring data in recent years, but the groundwater data set is limited both in terms of number of samples, and lack of monitoring wells in the SA/HAPA areas. While the investigation/characterization activities completed between 2008-2013 were fairly comprehensive; some areas around SWMU 10 appeared to have limited access due to OU1 excavation activities and steep side slopes. Impacts of the OU1 contaminated soil excavations (2009) and spring 2014 flood may not be fully understood giving the timing of these events relative to the OU2 investigations.
- The groundwater monitoring network in the area immediately east of the ETC site/SWMU 10 boundary does not have enough horizontal/vertical coverage of the aquifer to provide a clear understanding of contaminant distribution and migration trends. There is a gap of approximately 900 feet between the site perimeter monitoring wells (PMWA, PMCD, MW07) and the next downgradient monitoring well MW32 as shown on **Figure 2**. Recent data for PMWA, MW07, and MW32 indicates that contaminant flux may have increased in recent years into the Low Permeability Zone and Main Producing Zone downgradient of SWMU 10.

- The correlation between the groundwater concentration level for the HAPA (greater than 7,000 µg/L) and the “presence of non-mobile NAPL” is unclear. No specific calculations or other testing data could be found indicating why a value of 7,000 µg/L was selected.
- The upgradient groundwater monitoring well network is limited given that only three monitoring wells exist, and two of those wells are only screened down to the SZ interval.
- Groundwater monitoring has not been conducted since 2017.
- A few COCs (benzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene) appear to not be analyzed/routinely reported during recent groundwater monitoring.
- No pumping test data appear to be available for any of the aquifers at the site or its immediate surroundings.
- The impact of the stormwater retention basins located near the source area on groundwater levels and local flow directions is not clearly known. Siltation of these basins may help reduce infiltration and limit the impact to the local flow system on-site.

### 3.5.2 IMPLICATIONS FOR REMEDIAL STRATEGY

Incomplete or out-of-date characterization of the SA and HAPA could create challenges for effectively contracting and implementing the remedy in these areas. If a more performance-based contracting approach is used, bidders will likely account for site characterization uncertainty by adding additional cost to their bids. If a task-based contracting approach is used, the target treatment zone could be over-estimated leading to unnecessary remediation activities, or the target treatment zone could be underestimated, leading to incomplete remediation of source contamination.

The lack of monitoring wells (and other investigation data) in the area immediately downgradient from SWMU 10 presents two potential challenges for implementation of the current remedial strategy for the SA and HAPA. First and most significant is the delineation of the HAPA. **Section 2.4.2** describes that the HAPA is defined as soils/groundwater with non-mobile NAPL and naphthalene concentrations greater than 7,000 µg/L. It is very possible that groundwater in the area immediately downgradient from SWMU 10 has concentrations of naphthalene greater than 7,000 µg/L, however it is unclear if the other component of the HAPA definition, presence of “non-mobile NAPL” also applies to this area given the limited amount of soil/groundwater sampling that has historically occurred. Some soil oxidant demand testing conducted in the HAPA along the eastern boundary of SWMU 10 indicated that although groundwater concentrations greater than 7,000 µg/L are present in this area, non-mobile NAPL may not be present. This uncertainty will likely affect the understood/assumed boundaries of the HAPA.

Lack of monitoring wells in the area immediately downgradient from SWMU 10 will also create a challenge to assessing remedy performance as the remedy is implemented in the SA and HAPA. The Final Remedial Design (Versar, 2016) does include provisions for the Remedial Action (RA) contractor to install additional performance monitoring wells; however, the likely timing/sequencing of this approach would probably not provide a significant amount of pre-remediation baseline data for comparison. For that reason, installing and sampling additional monitoring wells in the area downgradient from the SWMU 10 eastern boundary prior to selection of an RA contractor may be more beneficial. See **Sections 5.1** and **5.3** for recommendations related to this data gap.

The data gaps related to no groundwater sampling since 2017, lack of upgradient groundwater monitoring data in the deeper groundwater intervals, and limited COC data are likely to be less impactful to implementation of the remedy in the SA and HAPA, particularly if it will be several years before remedy

implementation. In that case, groundwater monitoring could resume 1-2 years prior to remedy implementation to re-establish baseline conditions for assessing remedy performance.

The lack of pumping test data for impacted zones at the site may represent a data gap for any recirculation approach to amendment delivery and presents uncertainty in the local flow velocities as they may affect in-situ thermal treatment. A good location would be immediately upgradient of SWMU10 if access at the toe of the containment cell could be obtained. Alternatively, it could be on the south edge of SWMU just north of the borrow pit. One rule of thumb for applicability of thermal technologies other than steam to a site is to have flow velocities less than 1 foot/day. Since the impacted aquifers/aquitards have computed groundwater velocities on one third to one fifth of that value, there is some risk if the values used to compute the velocity (e.g., effective porosity, hydraulic conductivity) are poorly constrained.

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## 4.0 FINDINGS

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### 4.1 GENERAL FINDINGS

The observations provided below are not intended to imply a deficiency in the selected remedial alternative and/or the design of the selected remedy but are offered as constructive suggestions in the best interest of U.S. EPA Region 4 and the public.

### 4.2 TECHNOLOGY ASSESSMENT FOR SA AND HAPA REMEDY

The USACE evaluation team agrees with the overall remedial approach that has been developed by U.S. EPA. The emphasis on aggressive in-situ treatment technologies in the SA and HAPA should remove principal threat wastes that are currently providing a source of contaminants that impact both on-site and downgradient groundwater. By addressing these principal threat wastes first, flux of contaminants into the off-site groundwater should be significantly reduced, which will aid in effective remediation of downgradient groundwater contamination in the future. Because there are no current downgradient receptors, implementation of the remedy in the phased approach provided in the Final Remedial Design (Versar, 2016) seems appropriate; any efforts to remediate downgradient groundwater contamination before the SA and HAPA contaminant mass is significantly reduced would likely provide little benefit.

The remedial technologies that are proposed for the SA (SEE with ISCO/SEAR/ISEB as polishing technologies) and the HAPA (ISCO/SEAR/ISEB) are generally proven technologies that have demonstrated effectiveness at other sites with similar contaminants and site conditions. In addition, an ISEB pilot test performed at the ETC site proved that ISEB can be effective at destroying site contaminants. As is the case for all remedial technologies, addressing site specific conditions through proper planning and design will be important for the ETC remedy implementation. Some observations related to ETC site conditions and the proposed remedial technologies are included below.

USACE reviewed the cost estimates included in the Focused Feasibility Study (Black & Veatch, 2014). The intent of this exercise was to provide a high-level review, identifying findings such as significant unit rate changes which may have occurred in recent years, excessively high/low costs, etc. A summary of the cost estimate review is included in **Attachment D**.

#### 4.2.1 ASSESSMENT OF SEE TECHNOLOGY FOR THE SA

##### **Remedial Technology Assessment**

For the SEE technology that is specified for treatment of soils with heavy NAPL impacts (i.e., the SA), several site-specific variables are worth considering. USACE Engineering Manual 200-1-21 notes that shallow overburden depths and lower permeability soils may be less amenable to steam injection. Shallow overburden thickness limits the injection pressures that can be achieved with steam injection, which in turn can limit the temperature of injected steam and the radius of influence of injection wells. Steam injection is generally best-suited for sites with higher permeability soils and groundwater flow rates. Low permeability soils present challenges for effective heat delivery through steam, and at low groundwater flow rates other heating technologies may be more effective. One U.S. EPA Engineering Paper references a screening value of  $1 \times 10^{-4}$  centimeters per second (cm/sec, equivalent to a hydraulic conductivity of about 0.3 feet/day) or greater for steam injection to be effective.

Currently there is a very limited overburden thickness above the NAPL-impacted soils in the SZ of the SA due to the previous contaminated soil excavation activities that were completed in SWMU 10. **Section 3.2** provides a review of soil investigations that were performed in the SA and notes that heavily-impacted soils (either with residual NAPL or pooled NAPL) were present at shallow depths in several locations. This represents a potential limiting factor to success of steam injection; however, this limiting factor will likely be mitigated to some extent by backfilling of the SWMU 10 excavation prior to implementation of the SEE remedy. The extent of backfilling has not yet been specifically defined in the remedy selection or remedy design documents, and as discussed in **Section 4.2.3** of this Technical Memorandum, there are multiple possible options for how much backfill may be necessary. Greater amounts of backfill would likely allow for higher steam temperatures/pressures in the capillary-fringe soils.

**Section 3.1** discusses geology and hydrogeology of the ETC site, and notes that available information indicates that soils in the Surficial Zone and Low Permeability Zone have “moderate to moderately low hydraulic conductivities” (B&V, 2014) of 10-15 ft/day in the Surficial Zone and on the order of 1 ft/day in the Low Permeability Zone. Reported groundwater flow velocities in these two zones are also in the moderate range averaging about 0.13 ft/day. It is also notable that the SWMU 10 subsurface intervals that appear to have the most significant NAPL impacts are in the Low Permeability Zone, where layers of silt, clay, and silty/clayey sand were often observed in soil borings. The NAPL itself may impede fluid movement through the heavily contaminated soils.

Comparing the ETC site geology and hydrogeology to literature-provided screening values for SEE indicates that portions of the SWMU 10 Source Area may be challenging to treat with SEE or may be more amenable to other in-situ thermal treatment methods. Based on these observations, it may be beneficial to allow/encourage the use of multiple in-situ thermal treatment methods at the ETC site. SEE in combination with other heating methods (electrical resistance heating [ERH] or thermal conduction heating [TCH]) may present the best value and most effective treatment approach versus SEE-only.

In discussions while researching and preparing this Technical Memorandum, U.S. EPA indicated that they are agreeable to the possibility of using multiple in-situ thermal treatment technologies beyond SEE. While the Amended ROD and Final Remedial Design do not identify a specific other in-situ thermal treatment technology, the selected remedy in the Amended ROD states that “*Other approaches to thermal enhancement may be considered as well.*” U.S. EPA indicated they intend for the Amended ROD to allow for flexibility in use of multiple technologies.

### **Implementation Strategy Assessment**

The Phase 1 performance objectives presented in the Final Remediation Design (Versar, 2016) present some objectives/monitoring requirements that may be restrictive for an RA contractor, particularly if a more performance-based contracting approach is pursued for the Phase 1 and Phase 2 remedy components. Findings include:

- Using the concept of removal of free-flowing NAPL as a performance objective is conceptually a good idea that may be too difficult to practically implement. Defining free-flowing NAPL would be difficult, particularly given the possibility of different behaviors based on soil type, NAPL composition, temperature, water table elevation, etc.
- The post-SEE monitoring requirements (two years of measurements with no NAPL followed by a confirmation soil sampling event) - and the implication that SEE equipment would need to remain on-site in the event that these objectives are not met – will likely lead to high bid costs because many thermal remediation contractors do not have large pools of remediation equipment.



- If a performance-based contracting approach is used and the RA contractor is responsible for implementing both Phase 1 and Phase 2, it may be best to allow the RA contractor some flexibility in deciding if SEE can be applied in portions of the HAPA as well as the SA.

#### **4.2.2 ASSESSMENT OF SEAR/ISEB/ISCO IN THE SA AND HAPA**

##### **Remedial Technology Assessment**

There are several technology options allowed to address the HAPA and any residual contamination in the SA, including surfactant flushing, in-situ bioremediation, and in-situ chemical oxidation. There are potential synergies between bioremediation and in-situ chemical oxidation and these technologies have the advantage of contaminant destruction.

Surfactant flushing is primarily a mobilization technology and though it would make the NAPL more bioavailable for degradation, it would add additional carbon sources to be addressed by bioremediation. The mobilized hydrocarbons would have to be captured for treatment, and there would be a risk of incomplete capture and enhanced mass flux to the downgradient area and possibly to deeper portions of the aquifer system. The ability of various surfactants and co-solvents to create the appropriate micelles to enhance the mobility would have to be explored and this would be done with the added variables of elevated temperature and altered NAPL viscosity and density. In all, there are a number of reasons to avoid the use of surfactant flushing.

The application of ISCO at the site must include the use of a persistent oxidant to allow the dispersion and diffusion of the oxidizer through the heterogeneous aquifer materials. Though past studies have considered a calcium peroxide as a possible oxidant, other oxidants have advantages. Persulfate is a persistent oxidant that can be activated by heat, such as will be present following in-situ thermal treatment. The oxidant demand will be substantial and leveraging the oxidant with other synergistic processes should be considered to allow further polishing of residual contaminant mass.

Naphthalene is degradable under both aerobic and anaerobic conditions. The aerobic degradation of naphthalene has been demonstrated at the site with the oxygen sparging pilot study. Research has indicated that naphthalene is effectively degraded under sulfate reducing conditions. References can be provided. The reaction with persulfate generates ample sulfate ions that would be an appropriate electron acceptor for the degradation of high concentrations of naphthalene in the current anaerobic conditions. Though not well studied, there is also some evidence other PAHs may also be effectively degraded under sulfate-reducing conditions. Elevated subsurface temperatures will likely increase biodegradation reaction rates and thermophilic bacteria are generally aggressive in degradation. Biodegradation, particularly after in-situ thermal treatment, at the Visalia, California wood treating site contributed significantly to mass removal (U.S. EPA, 2009).

Natural levels of sulfate in the site groundwater appear to be in the tens of mg/L and appear to be diminished in portions of the plume. A source of additional sulfate may increase degradation, both in the direct delivery area, and downgradient through advective transport (into the areas of the plume with relatively lower concentrations). The presence of elevated sulfate from persulfate application may be problematic given the identification of sulfate as a concern at the nearby and somewhat cross-gradient Agrico Superfund site. The application of the persulfate in the highly contaminated area that would correspond to anaerobic conditions both in the target injection area and in the concentrated plume downgradient would provide the necessary capacity to reduce the sulfate to sulfide. Precipitation of iron sulfides in downgradient areas may represent the end point for the sulfides. If applied at appropriate levels, the sulfate will not propagate too far downgradient. Aerobic degradation may be suitable for

controlling the remaining dissolved naphthalene and related mobile PAHs downgradient of the sulfate reducing conditions.

### **Implementation Strategy Assessment**

The Final Remediation Design OU2 (Versar, 2016) currently indicates that remediation of the HAPA using the SEAR/ISEB/ISCO technologies will occur in a distinct operational phase separate from the Phase I remediation of the SA. While this approach would likely make evaluation of the Phase I remediation in the SA more straightforward, some scheduling efficiencies and potential synergies between the Phase 1 and Phase 2 remediation technologies could be lost. In particular, as discussed above, some of the potential ISCO and ISEB technology applications that could be performed in the HAPA could benefit from the applied heat that will be introduced into the subsurface while remediating the SA. Simultaneous treatment of the SA and HAPA areas may also be possible to some extent, which could shorten the amount of time necessary to implement the remedy in the SA and HAPA. Infrastructure from the thermal treatment, such as recovery wells, may be repurposed for injection of ISCO/bioremediation amendments.

The inclusion of the Phase 1 and Phase 2 treatment actions in a single performance-based contract would allow the contractor to best identify the balance between thermal treatment and ISCO/in-situ bioremediation, both in terms of areas of treatment and timing to leverage the benefits of heating discussed above. If funding is not available to include both phases in one contract, the Phase 2 contract should overlap with the end of the Phase 1 actions to benefit from the elevated temperatures.

The delivery mechanism can be left to the performance-based contractor, but the boundaries of the HAPA treatment zone may include areas of elevated dissolved concentrations of naphthalene east of the site. In this case, some type of recirculation approach may be advantageous to speed delivery of oxidant within the target zone under the surface features (i.e., railroad tracks, recycled asphalt piles) that preclude vertical wells or direct-push borings. Extraction wells east of the railyard with injection wells on the eastern site boundary may be adequate to deliver a persistent oxidant. One obstacle would be to provide treatment facilities outside the site. Extracted water piping could be installed within the existing horizontal well to deliver the water to an on-site plant. Drilling out the existing horizontal oxygen sparge lines within the outer casing/screen may be cheaper than directionally drilling a new pipeline. Using existing piping in the horizontal well would not likely be feasible due to the small diameter of the individual pipes, which would limit flowrates.

#### **4.2.3 ASSESSMENT OF SITE CIVIL ENGINEERING NEEDS**

The need for site civil engineering work prior to remedy construction is generally acknowledged in the Final Remedial Design (Versar, 2016) and Focused Feasibility Study (B&V, 2014); however detailed discussion of the civil engineering work is not included given the scope of those documents. Some further assessment of the site civil engineering work that will need to be conducted has been included below.

Currently, the fringes of the SA and HAPA intersect the side slopes of the SWMU 10 excavation; furthermore, a portion of the SA overlaps the bowed-in portion of the SWMU 10 sheet pile wall. Both of these conditions will likely create challenges to installing wells for remediation. To provide access along the current side slopes of SWMU 10, the excavation could be benched instead of using linear slopes. The bowed portion of the SWMU 10 sheet pile wall (~120 linear feet of sheet pile) will likely need to be removed to allow access for drilling equipment. The other portions of the sheet pile wall may not need to be removed; given that the sheet pile wall doesn't extend very far into the water table, it's unlikely that the wall would significantly impact the Phase 1 and Phase 2 remedy as long as access for well installation isn't an issue.

The removal of the sheet pile wall may present an opportunity for excavation of remaining contaminated soil located in the vadose zone/capillary fringe near the SA3 area (see **Figure 4** and **Section 3.2** for discussion of remaining contaminated soil). However, this would likely require installation of another temporary sheet pile wall to avoid soil sloughing. Better definition of the volume of contaminated soils, contaminant levels, and costs to erect a temporary sheet pile wall would likely be needed to determine the value of this additional excavation.

Water table intrusion and stormwater drainage also likely need to be addressed prior to remedy implementation. The current depth of the SWMU 10 excavation is approximately 47 feet msl. Not considering the 2014 flood, the maximum water table elevation reported in ETC site documents is ~51 feet msl. Based on these elevations, the SWMU 10 excavation will need to be backfilled to avoid groundwater intrusion during remedy implementation. Not backfilling the excavation would create obvious safety/access issues if there is standing water, and it would likely not be possible to construct a vapor barrier as part of the SEE remediation. Two possible approaches for backfilling are detailed in the table below:

**Table 4.1 – Potential Site Backfilling Options**

Option	Advantages	Disadvantages
Backfill to an elevation that would protect against groundwater intrusion. Assuming 10 feet of backfill to raise SWMU 10 from 47 feet msl to 57 feet msl, this would require approximately 15,000 cubic yards of backfill material	<ul style="list-style-type: none"> <li>• Less backfill soil required – lower construction cost/duration</li> <li>• Less backfill means drilling contractors will require less drilling footage to install wells/borings during the SA and HAPA remedy implementation, leading to lower drilling costs</li> </ul>	<ul style="list-style-type: none"> <li>• Stormwater will not naturally drain out of the excavation. Active stormwater management (sump system) or some type of passive infiltration gallery would be required</li> <li>• Removal of the sheet pile wall will likely require importing additional soil to ensure a stable slope along the north side of SWMU 10.</li> </ul>
Backfill to an elevation that would allow for gravity drainage of stormwater out of the SWMU 10 excavation and into the nearby OU1 soil borrow pit or a storm sewer. Assumed elevation of SWMU 10 would be approximately 73 feet msl (26 feet of backfill), requiring approximately 40,000 cubic yards of backfill material	<ul style="list-style-type: none"> <li>• No need to manage stormwater</li> <li>• Additional depth of backfill soils would potentially allow for better injection of steam into contaminated soils near the groundwater table.</li> </ul>	<ul style="list-style-type: none"> <li>• Higher backfill soil volume would require greater construction cost/project duration (mitigated if there is a local backfill source).</li> <li>• Stormwater infrastructure would need to be verified. A recent site visit indicated that a stormwater force main pump was removed from the adjacent north stormwater pond.</li> </ul>

## 4.3 DESIGN CHARACTERIZATION NEEDS

### 4.3.1 PREVIOUSLY COMPLETED DESIGN CHARACTERIZATION

A summary of design characterization activities that have been completed to-date is included below along with an assessment of the results of those characterization activities and utility for future remedy implementation. Discussion about future design characterization needs is provided in the following subsection, **Section 4.3.2**. The summary provided below generally focuses on technology-specific design characterization activities; other general characterization/investigation activities such as the TarGOST profiling, sonic borings, groundwater sampling, etc. are discussed in detail in **Section 3**.

#### **Solidification/Stabilization Bench Scale Study**

NAPL-impacted soils collected from beneath the water table were used for a bench scale study to assess the ability to stabilize/solidify contaminated soils. Three stabilizing agents (Portland cement, Portland cement with bentonite, and Portland cement with blast furnace slag) were utilized in the bench scale test. The results of the bench-scale test indicated some decrease in soil permeability, although control runs were not included to provide a baseline for assessing the effectiveness of the stabilizing agents. Because the OU2 remedy does not incorporate solidification/stabilization, the results of this study would be minimally useful for future remedy design.

#### **Oxidant Bench Scale Study**

In May 2009, a bench scale study was completed using Cool-Ox<sup>TM</sup>, a proprietary oxidant that contains calcium peroxide powder. The exact location of the soil samples used for this study was not provided in the study write-up, but based on contaminant concentrations, the soils were obviously NAPL-impacted. Two different experimental runs were used, one with 20 grams of reagent applied instantly, and another with two 10-gram applications of reagent at different times. In both instances, the ratio of oxidant to total PAHs was approximately 1.5 grams per gram. Both experimental runs showed removal of total PAHs, PCP, and benzene, with the run using the two 10-gram doses showing slightly better removals (~90% compared to ~80% in the other experimental run). The study results also indicated that surfactants were likely produced during the study, based on decreased surface tension measured in filtrate collected from the test. It is important to note that the conditions used during the study (preparation of a 2-to-1 water to soil slurry and apparent continuous mixing) likely created a favorable process for distribution of the oxidant which would not necessarily represent the effectiveness of oxidant delivery under real-world conditions.

#### **Oxidant Demand Study**

An oxidant demand study was completed using 11 different soil samples collected from multiple depths at four different test boring locations – PMW-A, PMW-B, RDSB02, and RDSB04 (see **Figure 5** for locations). The soils used in this study represented two different regimes: soils from PMW-A and PMW-B were described as having a “creosote odor” and total SVOC concentrations between approximately 300 – 900 micrograms per kilogram (µg/kg). The soils collected from PMW-A and PMW-B were generally in the same depth intervals where elevated TarGOST responses were observed for locations TG21, TG23, and TG25. No visible NAPLs were observed in these intervals except for a possible NAPL stringer in the PMW-B interval from 58-58.3 feet bgs. The soils collected from RDSB02 and RDSB04 were visually impacted with NAPL to a significant extent and had elevated total SVOC results of approximately 16,000,000 – 20,000,000 µg/kg.

The soils collected from the heavily-NAPL impacted locations, RDSB02 and RDSB04 showed complete consumption of the potassium permanganate oxidant (100 grams of potassium permanganate were consumed per kilogram of wet soil). The soils from PMW-A and PMW-B showed significantly less potassium permanganate oxidant consumption – between 2.00 g/kg and 5.36 g/kg, and the interval with the highest oxidant consumption may actually have been influenced by some locally-present natural

organic matter: wood and dark gray/black clayey soils were observed from between 110-117 feet bgs in PMW-A. The low oxidant demand in soils from PMW-A and PMW-B may be evidence that there is not significant amounts of adsorbed soil contamination (i.e., non-mobile NAPL) present in this area. USACE also calculated a theoretical naphthalene soil concentration of 10,100 µg/kg that would correspond to the presence of non-mobile NAPL, using the calculations described in the EPA's 2009 Groundwater Issue, *Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites*. This concentration was roughly an order of magnitude higher than the naphthalene concentrations in soil samples collected from the PMW-A and PMW-B locations. It should be noted that chemical concentrations after oxidants had been added were not reported as part of this study, which limits the ability to confirm COC destruction levels and how much of the oxidant demand was caused by site COCs versus natural soil oxidant demand.

### **NAPL Product Mobility Test**

Soil from three roto-sonic boring locations was collected for a NAPL product mobility test in April 2013. The test method consisted of centrifuging the soils at 1000 times the force of gravity. Samples were collected before and after the centrifuging to assess NAPL and water saturation in the soils. A summary of results from the product mobility test is included in the table below:

**Table 4.2 - NAPL Product Mobility Test Results**

Sample ID (Depth feet bls)	Dry Bulk Density (g/cc)	Total Porosity (% Vb)	Initial Saturation (% PV)		Final Saturation (% PV)		Observation
			Water	NAPL	Water	NAPL	
SB020 (56.7)	1.57	41.0	36.8	33.5	9.2	21.3	Dark brown DNAPL produced; clear water produced
SB022 (36.1)	1.54	42.0	19.7	49.6	3.0	10.6	Dark brown DNAPL produced; clear water produced
SB022 (55.6)	1.48	44.6	47.9	28.8	11.2	16.2	Dark brown DNAPL produced; cloudy water produced

Table from 2014 Focused Feasibility Study

bls =below land surface; g/cc = grams per cubic centimeter; Vb = bulk volume; PV= pore volume

The results of the NAPL product mobility test indicated that while most of the water could be removed from the soil matrix by centrifuging (73% - 85%), generally less of the NAPL could be recovered (36% - 79%), and a significant portion of NAPL still remained within the soil matrix after centrifuging. This indicates that traditional physical remediation technologies such as groundwater or multi-phase extraction would not be capable of total removal of NAPL in soils. Comparing the results from this study with published results from PTS Laboratories (the study authors) indicated that the NAPL recoveries for the ETC samples were on the high-end of observed values. The higher removal rate in SB022 (36.1 feet bls) may be related to a coarser soil type but could also be affected by the initial NAPL concentrations. Information in the study write-up did note that the SB022 (36.1 feet bls) sample had less fine sand and silt/clay-type particles compared to the other samples.

### **In-Situ Oxygen Injection/Enhanced Biodegradation Study**

The most significant design characterization completed to date for OU2 groundwater was an oxygen injection pilot study conducted in 2009. This pilot study involved construction of a horizontal injection well drilled underneath the adjoining east railroad property (see **Figure 2** for location information). The horizontal well was drilled to approximately 100 feet bgs (approximately -15 feet msl elevation – corresponding to the Low Permeability Zone); three 170-foot long screened intervals were installed within the boring.

High-purity oxygen gas was injected into the horizontal wells using an on-site system which collected and purified oxygen from atmospheric air. The gas injected into the subsurface reportedly had an oxygen concentration of 90-95%. The oxygen injection pilot study operated for a period of approximately one month, beginning on July 24, 2009. A second phase of oxygen injections reportedly occurred in 2010 over a period of 89 days, but specific details of that test could not be found.

Noticeable increase in dissolved oxygen groundwater concentrations were observed in four of the six nearby performance monitoring wells following the 2009 injections, approaching the oxygen saturation level for some of the closest monitoring wells (HW2PMWA91 and HW3PMWA91). During the second injection event, increased dissolved oxygen was observed in the two performance monitoring wells that had not seen increases during the 2009 injection event – HW2PMWB71 and HW2PMWC55. The increases appeared to occur after 30+ days of injecting, possibly indicating a longer time for the dissolved oxygen front to migrate to these monitoring wells.

Microbial testing was also completed, using both simple plate count testing methods as well as specific functional gene analysis (quantitative polymerase chain reaction testing). The microbial testing indicated increases in microbial populations in samples collected at the end of the pilot study.

Groundwater samples have been collected from the pilot study performance monitoring wells following the 2009-2010 test, providing data related to the short-term and long-term efficacy of the pilot study. **Section 3.3.1** discusses general groundwater monitoring trends. The most significant response following the pilot test was observed in HW2PMWB71 and HW2PMWA91. Following the 2009 injections, these two wells saw naphthalene decrease by roughly 50% of the pre-injection concentrations; however the naphthalene concentrations then rebounded to roughly the same levels observed prior to the 2009 injections (note that there was no data for these monitoring wells prior to 2009, so assessment of rebound and historical baseline levels is limited). Following the second injection event in 2010, naphthalene significantly decreased again in these two monitoring wells, and the level of rebound was much less notable than what occurred after the first injection event in 2009.

Reductions in naphthalene were also apparent in other performance monitoring wells, most notably HW2PMWC55 and HW3PMWA91. Naphthalene dramatically decreased following the first injection events in 2009. Rebound did occur, but it was delayed compared to rebound at the other monitoring wells. One notable occurrence is concentrations of naphthalene in HW3PMWB71 following the oxygen injection pilot study. Beginning in May 2012, naphthalene concentrations in this monitoring well spiked dramatically to 8,800 µg/L; well above the previous maximum concentration of 2,200 µg/L. Naphthalene concentrations have been erratic in this well since 2012. One theory that could potentially explain this was presented by U.S. EPA during the discussions for this assessment: the horizontal injection wells may be acting as a conduit for preferential groundwater flow

#### **4.3.2 ASSESSMENT OF ADDITIONAL DESIGN CHARACTERIZATION NEEDS**

The OU2 Final Remedial Design (Versar, 2016) does a good job of identifying the majority of the design characterization activities that will be needed for remedy implementation in the SA and HAPA areas. The remedial design specifies that the remedial action (RA) contractor will complete these pre-remedial

bench-scale and pilot-scale characterization activities. USACE mainly agrees with this strategy because design of bench and pilot-scale studies is often dependent on the specific remedy implementation strategies that an RA contractor uses. Therefore, bench and pilot-scale studies (particularly focused on heating/injection radius of influence, equipment types/sizes, required subsurface temperatures, and injection amendment types) performed prior to selection of an RA contractor may not provide sufficient information for the RA contractor to implement the remedy without needing to recreate some of the work.

USACE believes that potential bidders will have sufficient information to be relatively comfortable with developing a bid for the remedial technologies specified for Phase 1 and Phase 2. This assumption is based on the previously completed design characterization activities (see **Section 4.3.1**) combined with the ample amount of industry experience at similar wood treating sites

Design characterization work that is performed prior to selecting an RA contractor should focus on narrowing down the uncertainty associated with the size of the SA and HAPA areas both due to potential changes in site conditions following completion of the investigation work in 2013 and data gaps from the previous investigation work. The OU2 Remedial Design (Versar, 2016) currently specifies that the RA contractor will complete “pre-remedial baseline sampling” to verify site conditions, update the CSM, and collect site-specific parameters. Investigations that are completed prior to selection of an RA contractor to verify site conditions and updated the CSM should limit the uncertainty that RA contractors must consider when preparing contracting bids. If that uncertainty is limited, it should lead to more competitive bids (less factor-of-safety costs) and less variability in assumptions between different bidders.

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## 5.0 RECOMMENDATIONS

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### 5.1 RECOMMENDATIONS TO ADDRESS DESIGN CHARACTERIZATION NEEDS

A summary of recommended design characterization activities to complete prior to selection of an RA contractor is as follows:

- Complete a subsurface soil/groundwater investigation to refine the horizontal and vertical limits of the SA and HAPA zones. A layout of recommended investigation areas is included on **Figure 4**.
  - Recommended investigation locations around the perimeter of the SA and HAPA zones would fill-in any data gaps that may be present due to limited previous investigation activities in these areas. Note that the side-slopes of the SWMU 10 pit/excavation represent the area that has had lesser amounts of investigation due to drill rig access issues. Completing additional borings in these areas would require some backfill/grading of the excavation to establish benches that could be used for drill rig access. These perimeter investigation locations could also assess potential changes in the orientation of the SA and HAPA zones due to the 2014 flooding event. **Figure 4** shows a possible layout for borings along the perimeter. A preliminary spacing of one boring every 100 feet is proposed (12 borings), along with three additional borings in the southern portion of SWMU 10, which is an area that has comparatively fewer historical investigation locations. Accounting for five additional step-out borings would yield a total of 20 perimeter boring locations.
  - Recommended investigation locations in the base of SWMU 10 could confirm previous investigation results. This area historically had a significant amount of investigation work, so the uncertainty regarding the SA and HAPA orientations is less significant than around the perimeter of the SA and HAPA. Therefore, fewer investigation locations are recommended for this area. **Figure 4** shows possible locations for six borings in the SA.
  - Investigations could be completed with a variety of drilling equipment, but USACE believes that direct push and/or roto-sonic would provide the best overall results. Either of these methods would provide the benefit of producing a physical soil core that can be logged, sampled for lab analysis, or sampled for other analytical purposes. Direct push may be limited by depth, particularly for locations outside of the SWMU 10 excavation or along the side slopes. Roto-sonic would not have the depth limitations of direct push but is more costly.
  - Visual logging and soil sampling for PAH analysis would be recommended for each boring location (particular interest would be collecting samples of fine-grained soils that are more likely to contain NAPL and/or appreciable volumes of dissolved-phase contamination). Other simple field tests such as a jar test or hydrophobic dye test could also be used particularly when NAPL is suspected to be encountered. Other soil-matrix tests such as porosity, dry bulk density, total organic carbon, and fractional organic carbon content should also be considered particularly in the HAPA areas as these tests may help to assess PAH distribution between the soil and pore water components. If



NAPL is encountered, collecting sample(s) to assess physical and chemical parameters should be considered.

- Install additional monitoring wells downgradient of the eastern boundary of the site to address a gap in monitoring well coverage downgradient of the site boundary. Based on historical site investigation results, these monitoring wells would likely need to be screened at multiple depths across LPZ and MPZ to cover the likely vertical extent of the groundwater plume. The process of installing a cluster of monitoring wells with different depths could continue to be used, or these monitoring wells could be installed as multi-level monitoring systems within the same borehole (such as a FLUTE™ or CMT Multilevel System). A configuration with possible locations for a transect of three monitoring wells is shown on **Figure 6**.
- In the area east of the SWMU 10 boundary, collect additional soil/groundwater samples to assess if the current definition of the HAPA is representative of conditions in this area. As **Section 3.5.2** and **Section 4.3.1** both discuss, presence of groundwater with naphthalene concentrations greater than 7,000 µg/L in this area may not represent a “substantial source for groundwater contamination”. Investigation methods which could help answer this question include simple soil sampling or some of the other characterization activities that have been performed at the site such as soil oxidant demand testing (if no residual NAPL is present, soil oxidant demand would be expected to be proportionally low). This additional characterization could be conducted simultaneous with installation of downgradient monitoring wells and the completion of borings along the eastern perimeter of the HAPA to minimize level of effort.
- Complete a pump test to confirm site-specific aquifer hydraulic conductivity, which will be important data for bidding and designing the in-situ thermal and SEAR/ISCO/ISEB remedy components. Pumping at a rate of approximately 10-20 gallons per minute over a period of 1-2 days would likely be sufficient. An upgradient/side-gradient location would be an ideal pumping location in order to minimize the potential for pumping highly contaminated groundwater. Possible locations are shown on **Figure 6**. In the event that contaminated groundwater was expected to be pumped, a portable granular activated carbon system would likely be capable of treating potentially contaminated groundwater given that the contaminants present in ETC groundwater are generally readily adsorbed onto granular activated carbon.
- Install additional monitoring wells upgradient of SWMU 10 to supplement the existing upgradient monitoring well network. These monitoring wells could be installed in similar locations as the existing upgradient monitoring wells MW37S, CC-PMW-002, and MWSB3, but at greater depths in order to characterize the LPZ and MPZ groundwater. Refer to **Figure 6**.
- Continue to complete periodic groundwater monitoring events of select ETC wells. The focus of continued groundwater monitoring events should be sampling wells closer to the ETC site, since these monitoring wells will provide data that will affect remedy implementation and performance monitoring in the SA and HAPA. A representative set of downgradient monitoring wells should also be included in these future groundwater monitoring events (such as boundary wells or wells with increasing/decreasing concentrations). Monitoring more often than every other year is not considered necessary, particularly if remedy implementation is still several years away. Some individual recommendations to consider for future groundwater monitoring events includes:
  - Ensure that existing upgradient monitoring well MWSB3 is sampled during each future monitoring event and include/evaluate sampling results for the performance monitoring wells that are sampled as part of the OU1 remedy (CC-PMW-001 and CC-PMW-002).
  - Sample the deeper intervals of MW12 (‘C’ and ‘D’) to assess the current extent of naphthalene downgradient/side-gradient of HW2PMW. If sampling results are low (below the naphthalene NADC), sampling could be discontinued.

- Consider limiting the number of far downgradient locations that are sampled, particularly if those monitoring wells have low detection levels and/or are downgradient from other monitoring wells that could serve as sentinel wells. Some wells which could be considered for suspension from periodic sampling include MW16I, MW24S-D, MW25S-D, MW31R, MW35-94, and MW36. In the future, sampling of these monitoring wells could resume as remediation in the SA and HAPA nears completion and focus shifts to the downgradient dilute plume areas.
- Ensure that all groundwater COCs are being analyzed during future monitoring events. Review of groundwater analytical data indicated that the dataset for benzene and the trimethylbenzene isomers was limited for most site monitoring wells.
- NAPL gauging is an inexpensive activity should be completed during groundwater monitoring in site monitoring wells that are located proximate to SWMU 10 (e.g. PMWA, MW07, H2PWM, MW32-147). This could be accomplished with an interface probe or bailer.

## **5.2 RECOMMENDATIONS RELATED TO TECHNOLOGY ASSESSMENT FOR SA AND HAPA REMEDY**

- Encourage bidders and the selected RA contractor to consider remedial strategies that use other in-situ thermal technologies or use SEE in combination with other the other in-situ thermal technologies. If this approach is used, consider slightly re-wording the Final Remedial Design document to more directly state that multiple in-situ thermal technologies can be used.
- Consider revising the performance objectives/remedial technology objectives for the Phase 1 remedy in the SA to provide more implementation flexibility for the RA contractor. This recommendation would be most applicable if the RA contractor is responsible for completing both Phase 1 (SA) and Phase 2 (HAPA plus SA polishing) of the remedy under a performance-based contracting approach. Specific recommendations include:
  - Use Phase 1 performance objectives that are less-specific than what is currently provided in the Remedial Design document. Consider performance objectives such as achieving a minimum target treatment temperature and reaching asymptotic mass recovery rates, which would ensure that the SEE remedy is appropriately operated. Once these performance objectives are achieved, the RA contractor could decide if continued/expanded operation of the SEE system is appropriate, or if the Phase 2 remedy elements could effectively be implemented to meet the Phase 2 performance objectives.
  - Provide the option for the RA contractor to use in-situ thermal treatment in portions of the HAPA if the RA contractor believes that this approach would be most effective at ultimately meeting the Phase 2 remedy performance objectives.
- Plan the sequencing and timing of Phase 1 and Phase 2 activities to take advantage of the synergies of the heating and in-situ chemical oxidation and bioremediation. As discussed in **Section 4.2.2**, the contracting approach should facilitate this to the extent possible.

## **5.3 RECOMMENDATIONS FOR A REMEDIAL DESIGN/REMEDIAL ACTION DELIVERY STRATEGY**

USACE's understanding of the site conditions, selected remedy, and remedial design indicates that there are five major stages to implementation of the remedy in the SA and HAPA areas (excluding bidding/contracting):

1. Pre-remedial characterization/baseline sampling
2. Major site civil preparations
3. Pre-remedial treatability testing (bench and pilot-scale)
4. Remedy implementation
5. Post-remedial performance monitoring

Separating these five stages into two distinct contract actions appears to be a remedial design/remedial action delivery strategy that will present the best opportunity for technical success and cost savings. Under this recommended approach, the first contract action would include the pre-remedial characterization/baseline sampling and major site civil preparations. It may be best to first complete some of the site civil improvements related to sheet pile wall removal, backfilling, and grading of SWMU 10. This would allow for improved access to collect samples in areas that have been previously inaccessible due to the physical limitations near the SWMU 10 slopes and sheet pile wall. The second contract action would occur after completion of the first contract action and include the remaining three stages of treatability testing, remedy implementation, and post-remedial performance monitoring.

**Advantages:** A delivery strategy that includes two contract actions would likely break up the remedial construction cost into more manageable segments that may be easier to fund and execute versus a single contract action with a larger overall value and longer duration. Separating the major site civil work from more traditional in-site remediation activities may also allow for a more diverse group of bidders for both separate contract actions. By contrast, a single contract action for all five stages identified above would likely discourage some environmental remediation contractors that are not comfortable with planning and executing major civil engineering work (grading, structural earthwork, and stormwater).

Completing pre-remedial characterization/baseline sampling prior to contracting for the remedy implementation should provide the benefit of limiting the amount of uncertainty that bidders must account for when preparing bids for the treatability testing, remedy implementation, and post-remedial performance monitoring. If there is significant uncertainty regarding the CSM (either due to data gaps or changes in site conditions since investigation activities ended in 2013), bidders will either factor that uncertainty into their bids (resulting in bids with high contingency pricing) or underestimate the level of effort to reach the remedial technology objectives.

**Disadvantages:** Delivering the remedial design through two contract actions may create real or perceived delays in project execution (assuming that funding would be available to execute all activities under one contract action). Completing site civil work prior to having a well-understood remedial design may create access issues for future installation of wells or other remedial equipment infrastructure.

## 5.4 OTHER RECOMMENDATIONS

The following recommendations do not directly address the evaluation areas identified for this assessment by U.S. EPA, but are also aimed at improving effectiveness, reducing life-cycle costs, and gaining site closeout.

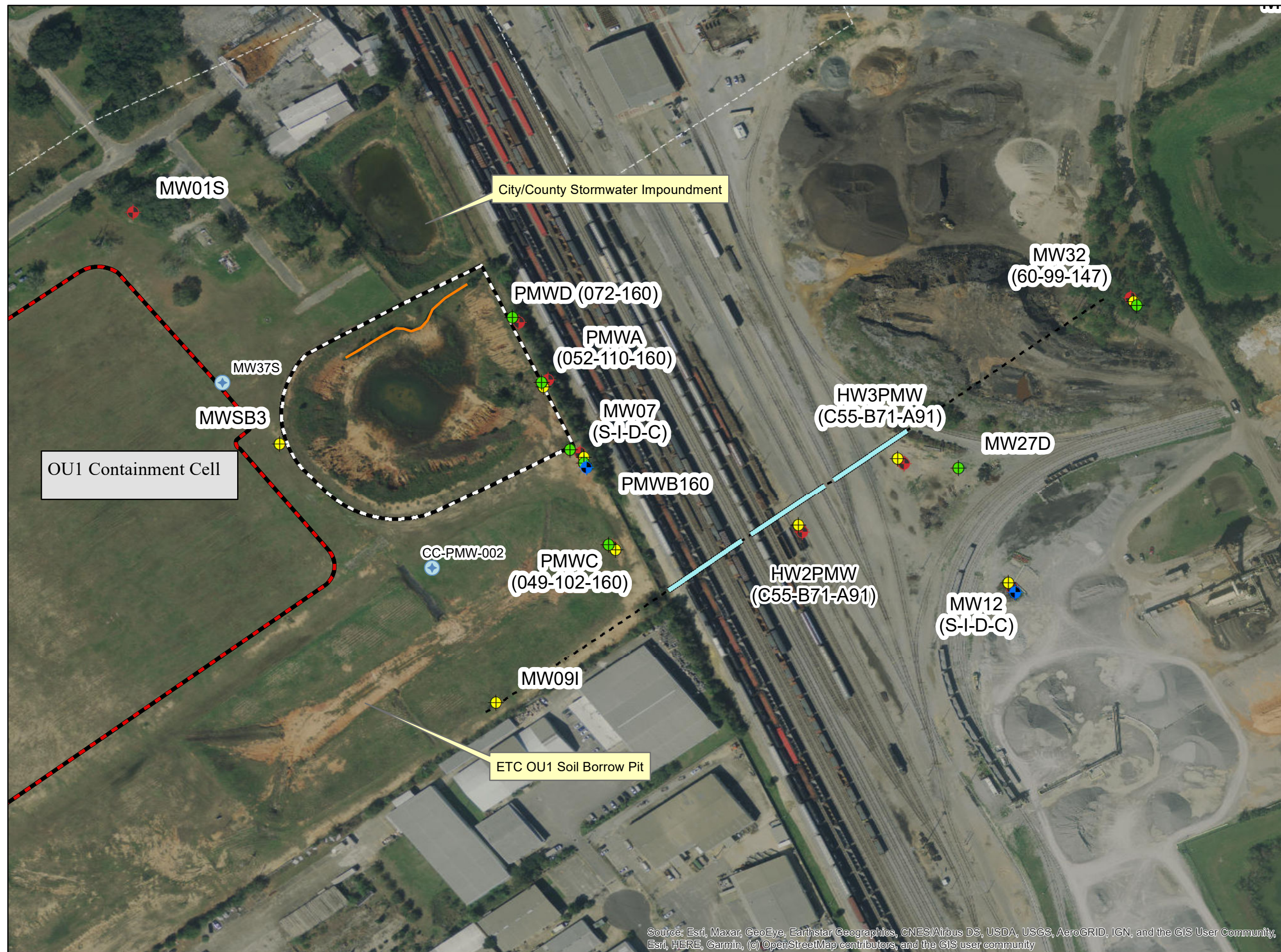
- Encourage contractors to consider green/sustainable cleanup practices when planning and implementing the remedy. Green/sustainable cleanup practices can be encouraged in open-ended ways through contract incentives or can be required in more specific ways (such as requiring contractors to complete best management practice (BMP) checklists. Some green/sustainable cleanup practices which may create benefits for the ETC site include:
  - Encourage re-use of recovered combustible NAPLs in equipment used on-site (such as boilers, pumps, etc.).
  - Use direct push drilling methods whenever feasible.
  - Encourage contractors to develop an engine/equipment idling reduction plan.
  - Use regenerable granular activated carbon.
- If possible, setup utility services (natural gas, water, electricity) such that those services are paid directly by U.S. EPA. This can avoid the markup that is associated with RA contractors paying for these services.

## **FIGURES**









**Figure 2**  
**SWMU 10 Map**  
**Escambia Wood Treating Site**



0 200 400  
Feet  
1 inch = 200 feet

- Legend**
- OU1 Monitoring Wells
  - Sheet Pile Wall
  - OU1 Cell Liner (approx)
  - Pensacola Clay Well
  - Main Producing Zone Well
  - Low Permeability Zone Well
  - Surficial Zone Well
  - Horizontal Bore
  - Horizontal Well Screen
  - SWMU10 Boundary



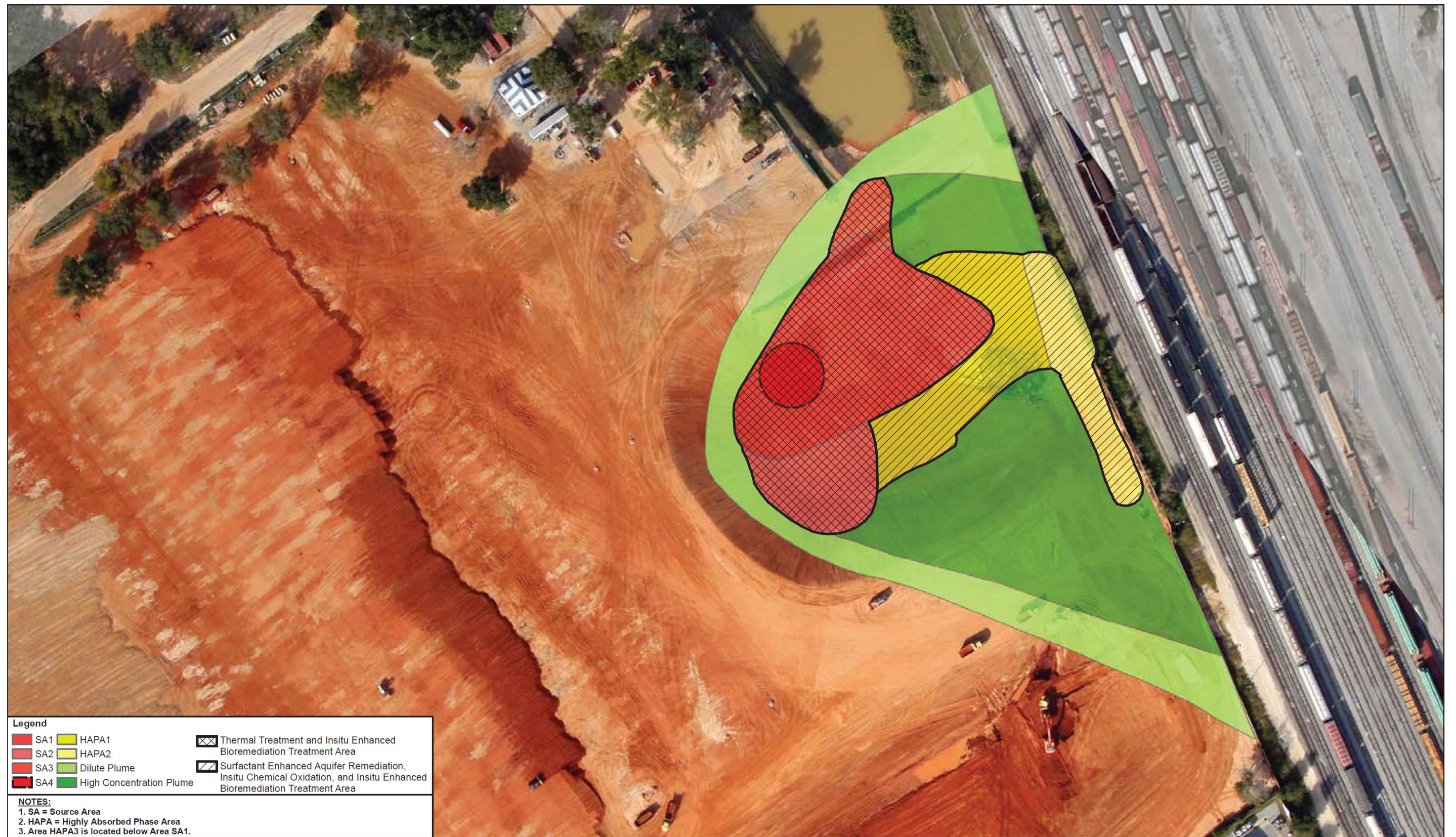
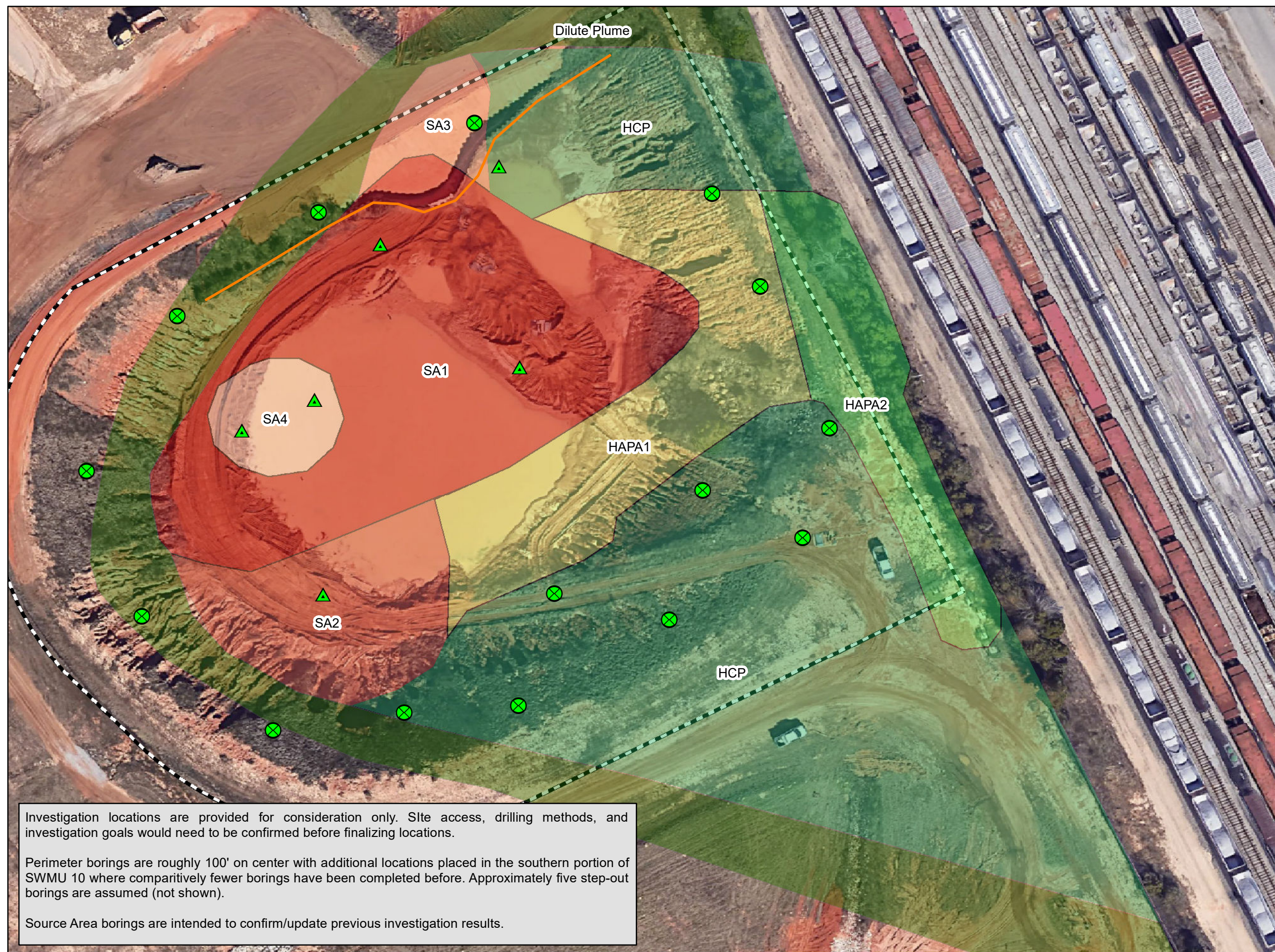


Figure 3 – Contaminated Media Zones (from 2014 Focused Feasibility Study)

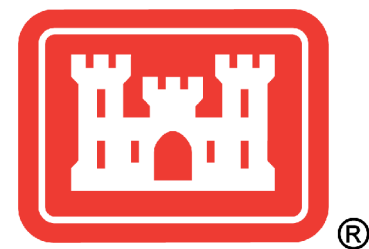




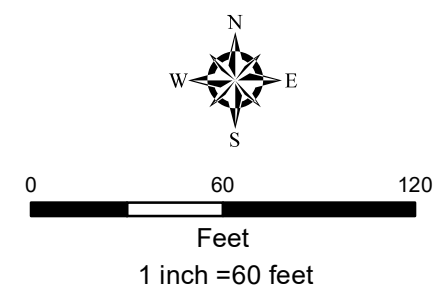
Investigation locations are provided for consideration only. Site access, drilling methods, and investigation goals would need to be confirmed before finalizing locations.

Perimeter borings are roughly 100' on center with additional locations placed in the southern portion of SWMU 10 where comparatively fewer borings have been completed before. Approximately five step-out borings are assumed (not shown).

Source Area borings are intended to confirm/update previous investigation results.



**Figure 4**  
**Possible Additional TTZ**  
**Investigation Locations**  
**Escambia Wood Treating Site**



- Legend**
- Possible Perimeter Boring
  - Possible Source Boring
  - Sheet Pile Wall
  - SA4
  - SA3
  - SA2
  - SA1
  - HAPA1
  - HAPA2
  - HCP
  - Dilute Plume
  - SWMU10 Boundary



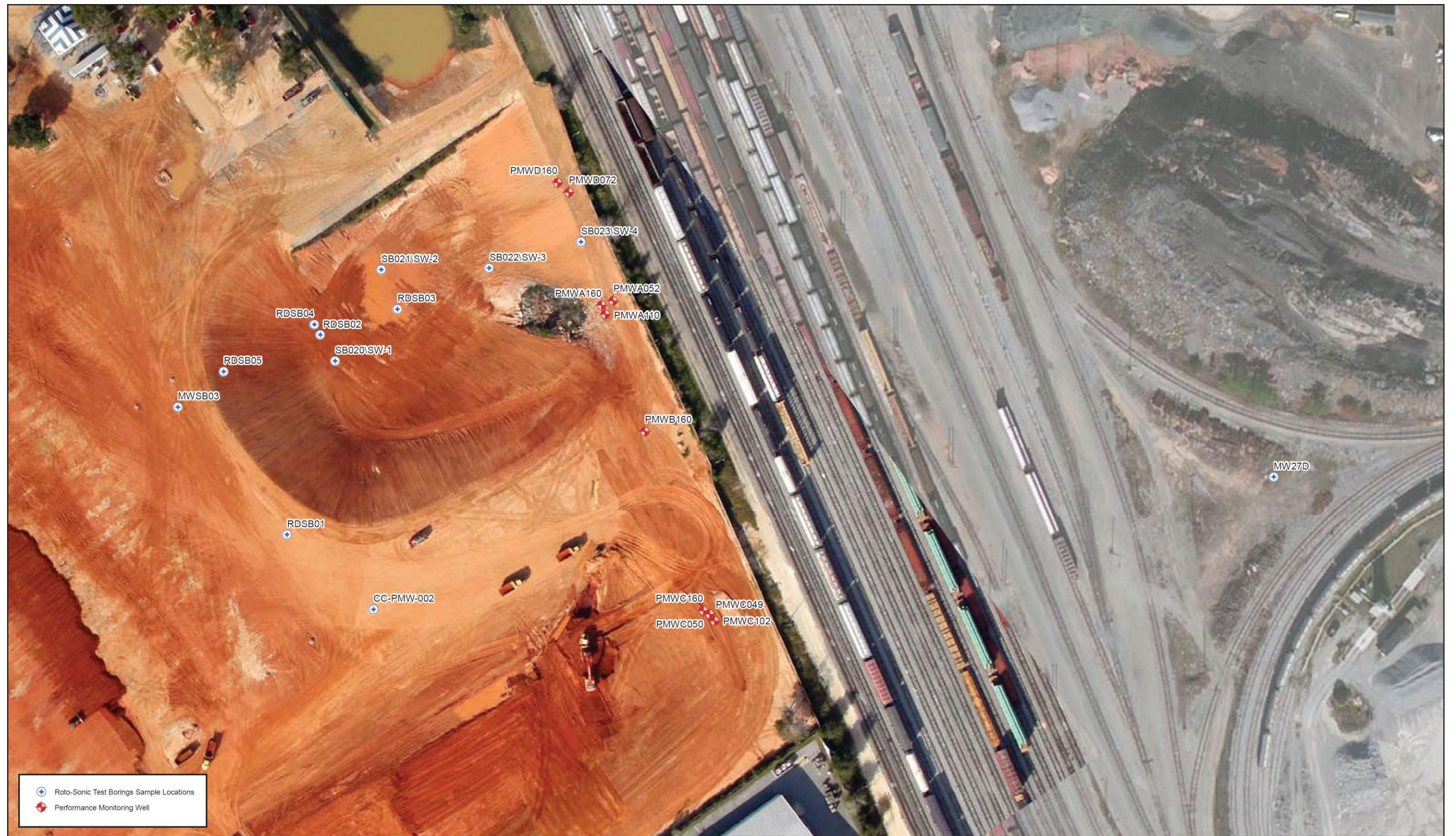
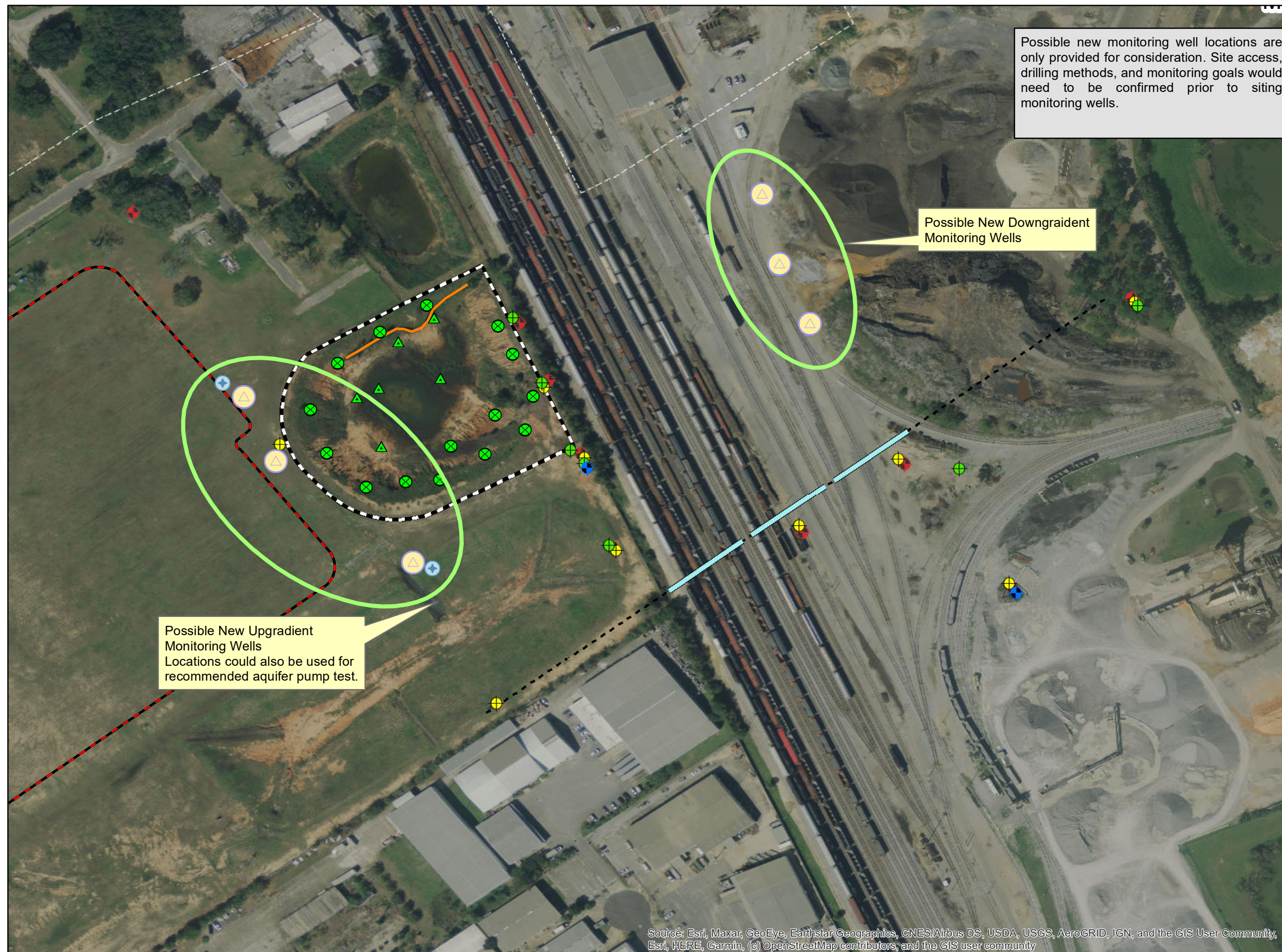
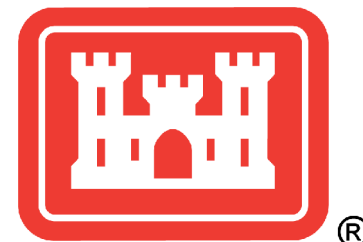


Figure 5 - Sonic Soil Boring Locations and Monitoring Wells (from 2014 Focused Feasibility Study)

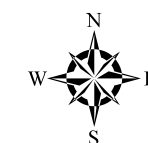




Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community



**Figure 6**  
**Possible New Monitoring Wells**  
**Escambia Wood Treating Site**



0 200 400

Feet

1 inch = 200 feet

**Legend**

- Possible Perimeter Boring
- Possible Source Boring
- Possible New Monitoring Wells
- OU1 Monitoring Wells
- Sheet Pile Wall
- OU1 Cell Liner (approx)
- Pensacola Clay Well
- Main Producing Zone Well
- Low Permeability Zone Well
- Surficial Zone Well
- Horizontal Bore
- Horizontal Well Screen
- SWMU10 Boundary



## **ATTACHMENTS**

**ATTACHMENT A**  
**Site Visit Photolog**



Southern stormwater impoundment - Looking south – no water present



Southwest corner of southern stormwater impoundment has a stormwater run-off pipe to carry water from the west part of the site





City stormwater impoundment looking northeast



City stormwater impoundment looking southeast – pump believed to have been located in cage





City stormwater impoundment – caged area. Next photos are due east of this

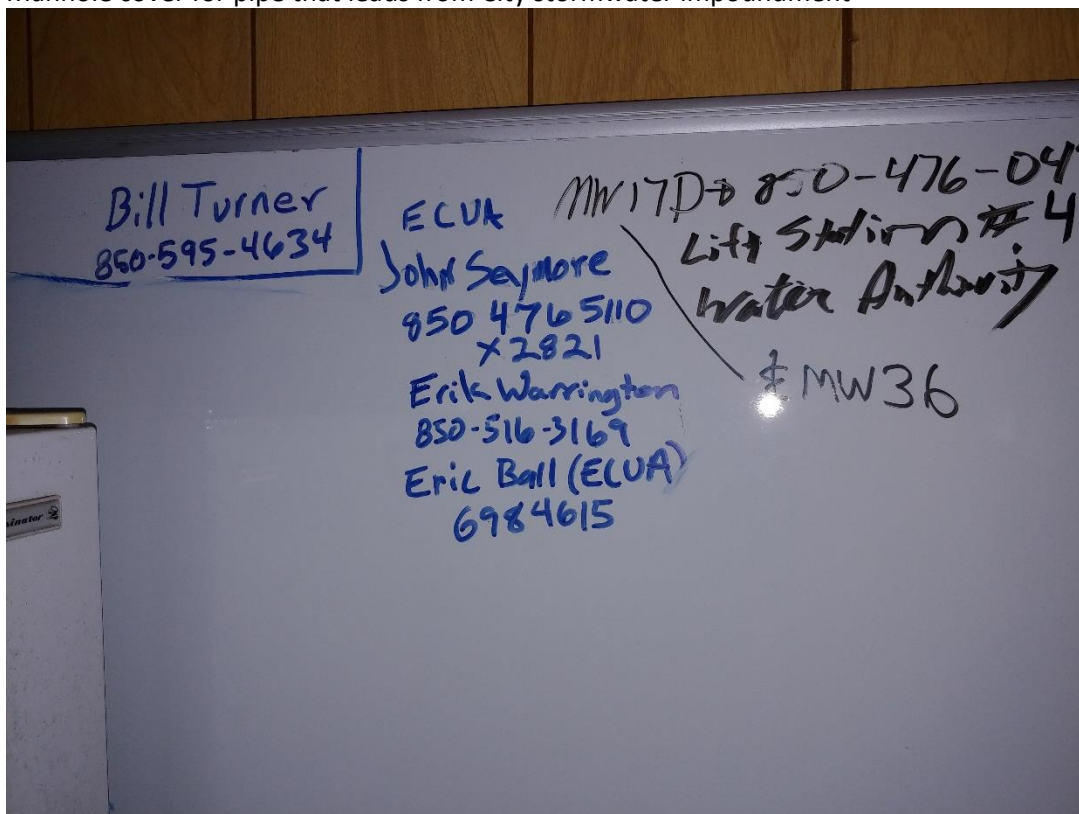


No meter for City stormwater impoundment pump





Manhole cover for pipe that leads from City stormwater impoundment



ECUA contact info – from a few years back. We think John Seymore was the lead guy there  
Lift Station #4 – most likely the name of the City stormwater impoundment pump





SWMU 10 sheet piling bulge



Another view of the sheet piling bulge





No water in SWMU 10 – probably less than 1-inch of rain this week



SWMU 10 looking northwest





SWMU 10 looking south



SWMU 10 looking west-northwest





Fence bent southeast part of SWMU 10



Far west end of sheet piling





Where hurricane debris was, looking north from SWMU 10 area



Looking towards NW corner of site – equipment for hurricane debris was there in the morning





All hurricane debris equipment gone in mid-afternoon



Some grass seed – we think the little furrows are from equipment that buried most of the seeds





**ATTACHMENT B**  
**Groundwater Data Review Information**

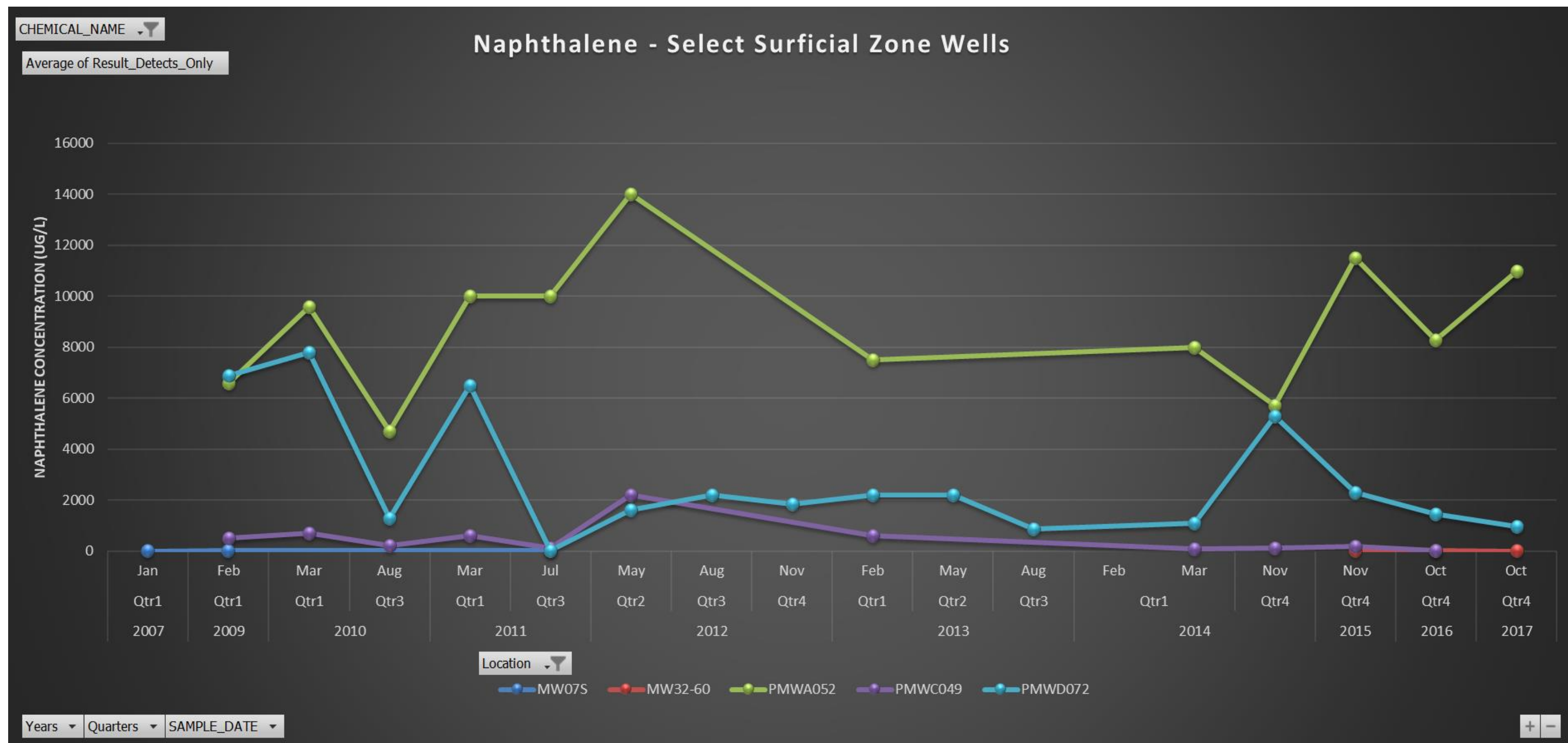


Figure B-1 Naphthalene in Select Surficial Zone Wells



Figure B-2 Naphthalene in Select Low Permeability Zone Wells

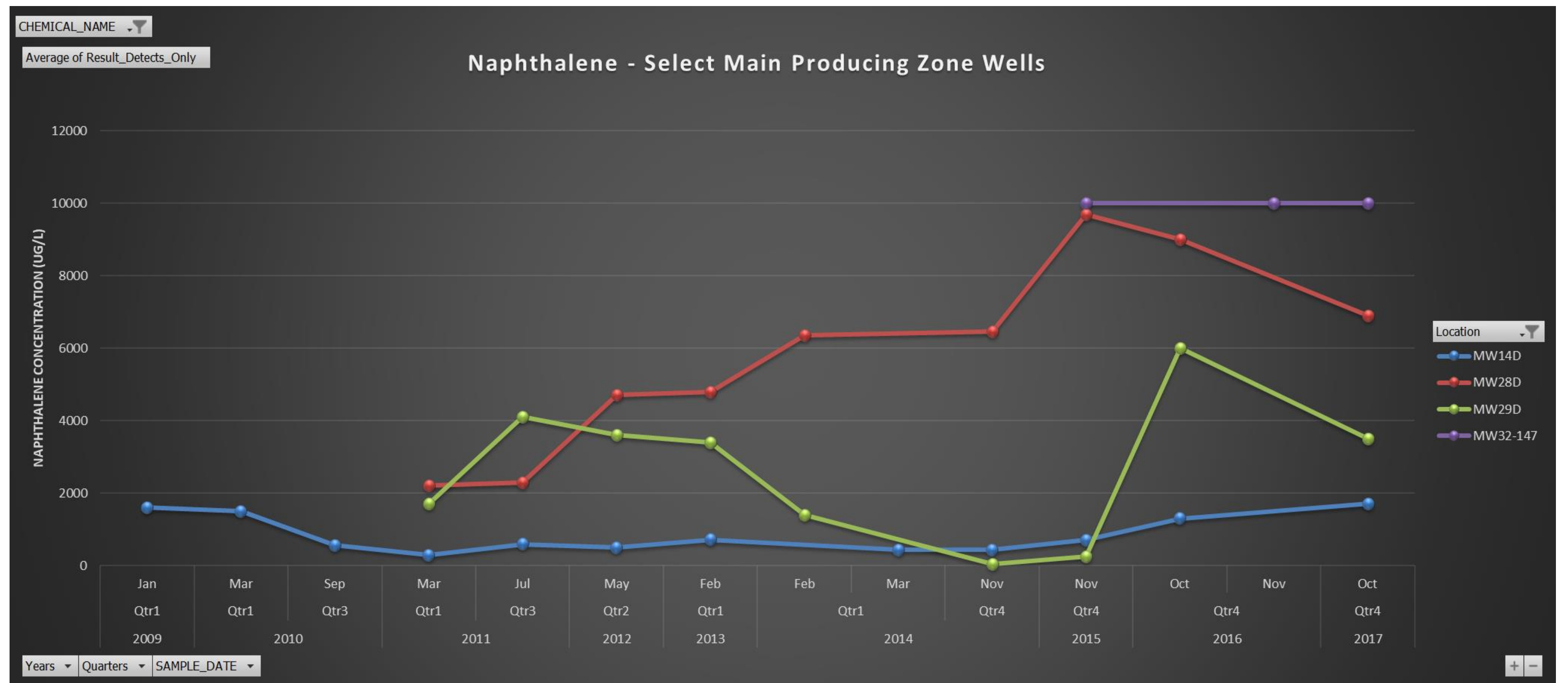


Figure B- 3 Naphthalene in Select Main Producing Zone Wells

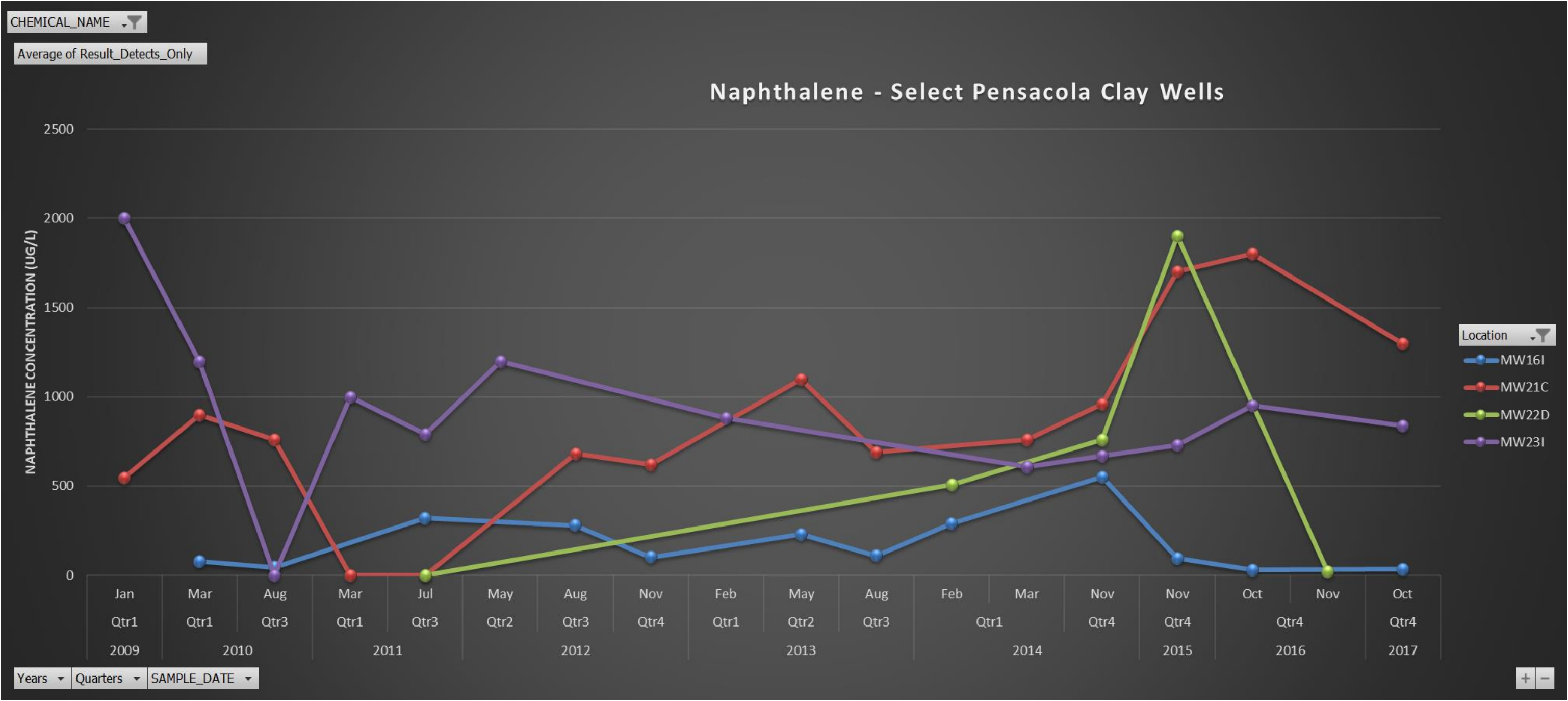


Figure B-4 Naphthalene in Select Pensacola Clay Wells



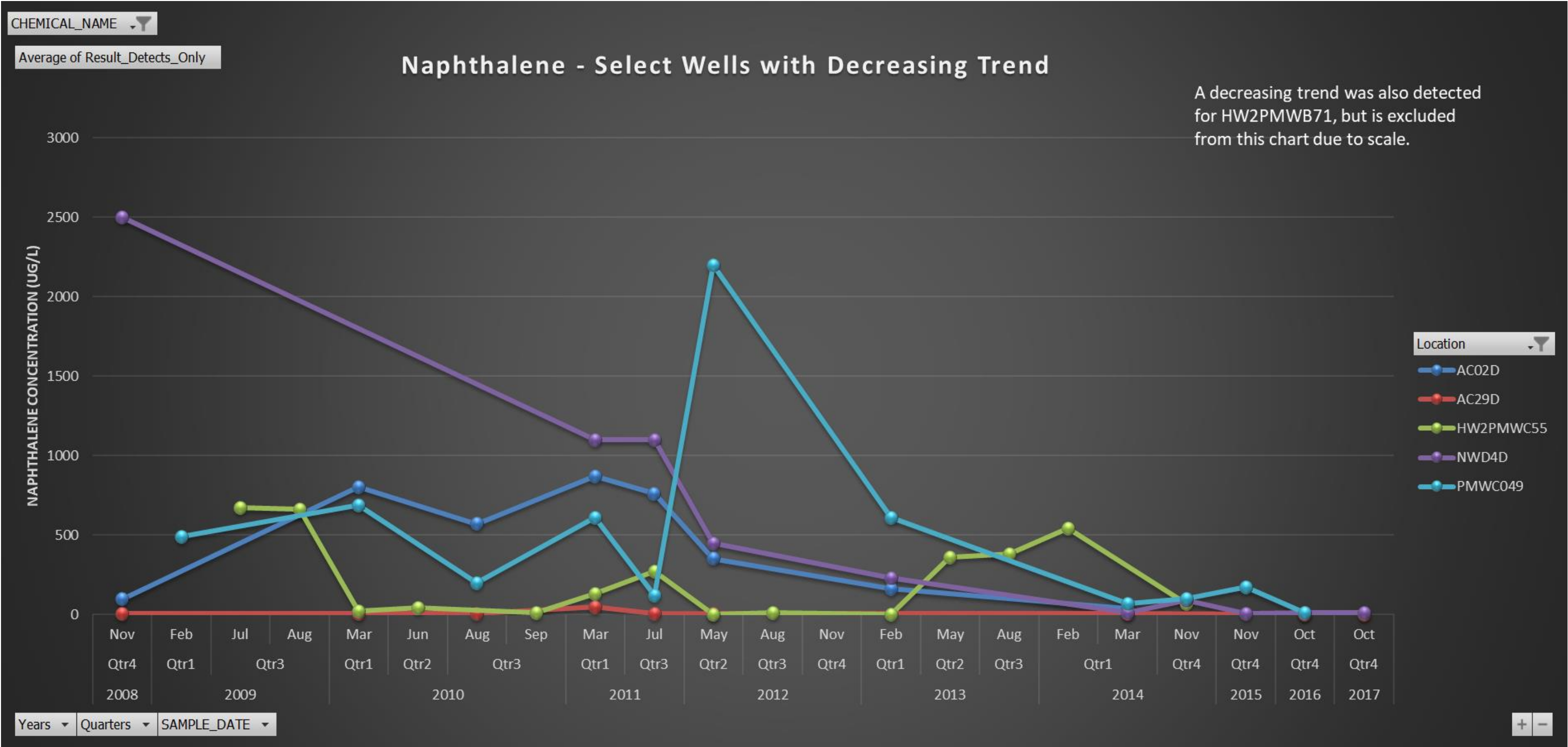


Figure B-5 Naphthalene in Wells with Decreasing Trend

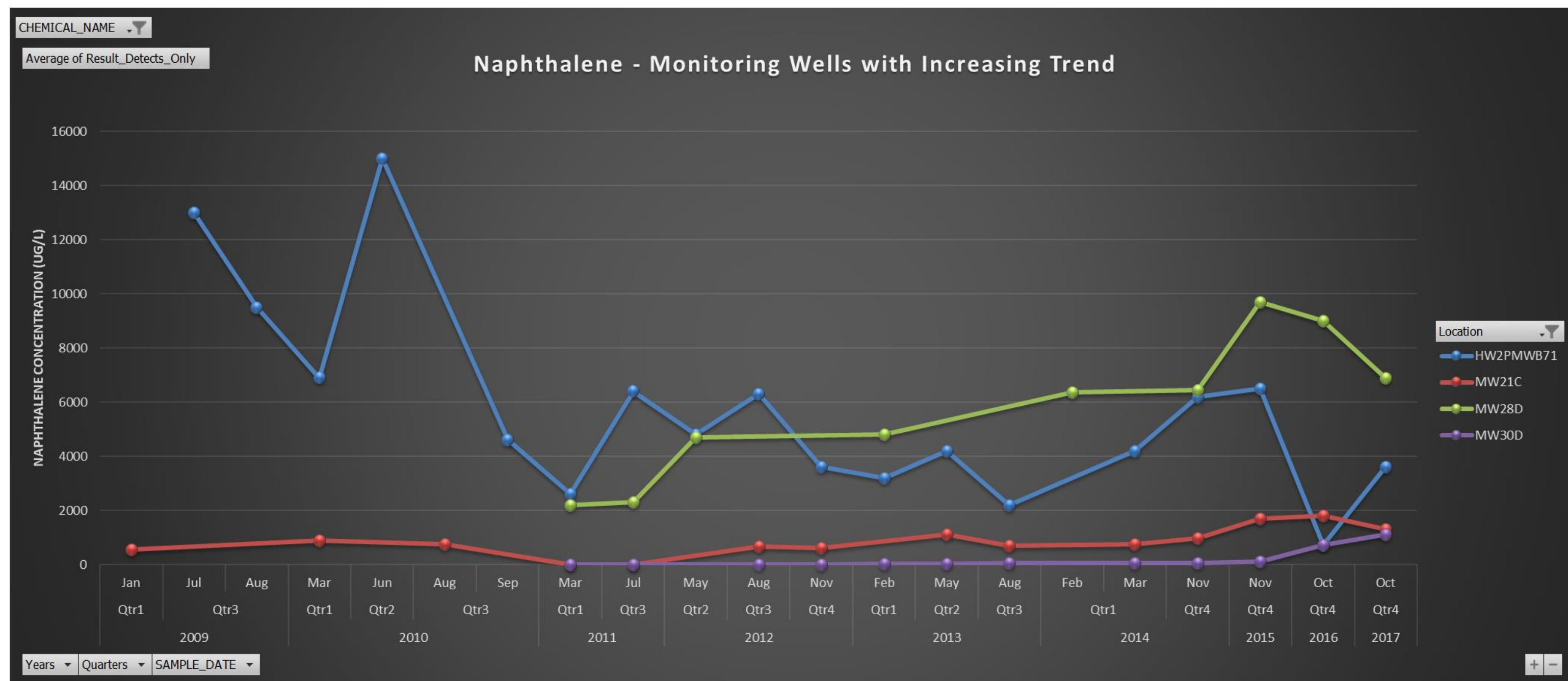


Figure B-6 Naphthalene in Wells with Increasing Trend

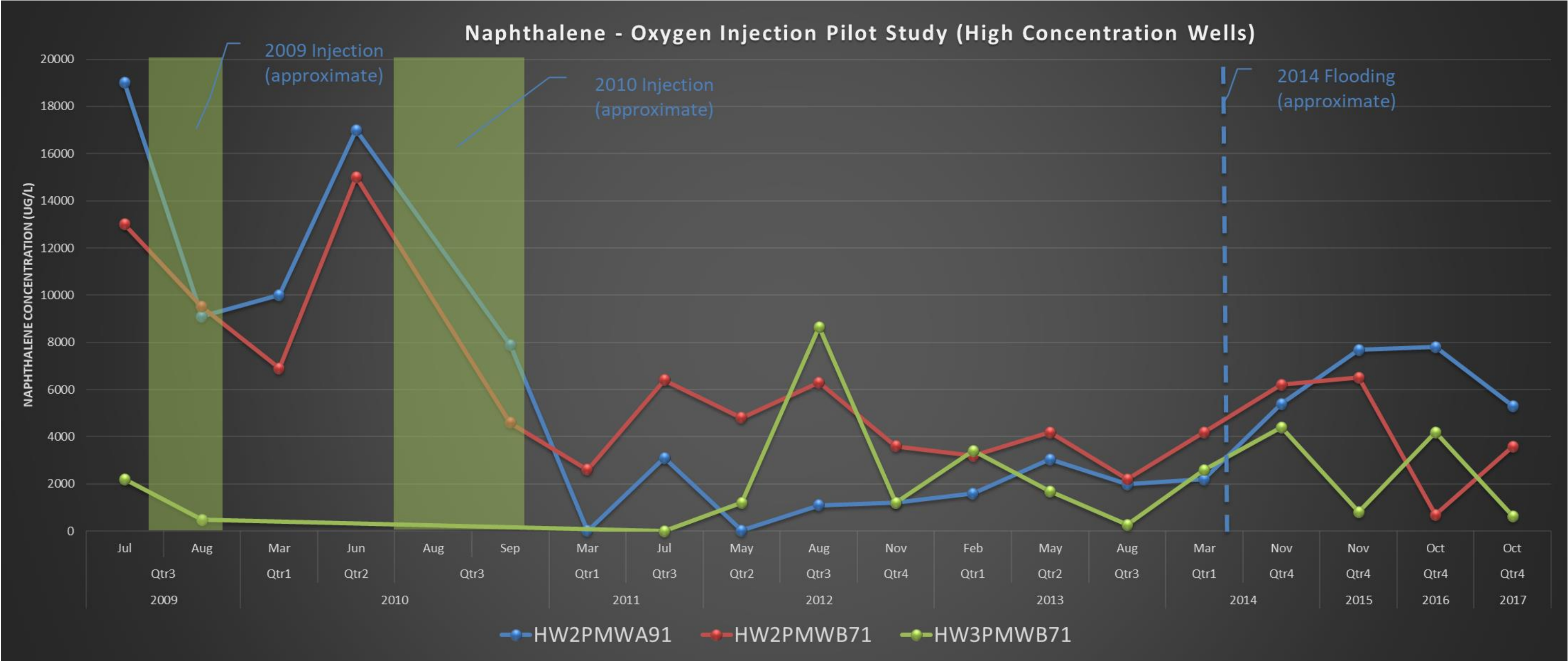


Figure B-7 Naphthalene in High Concentration Wells from Oxygen Injection Pilot Study



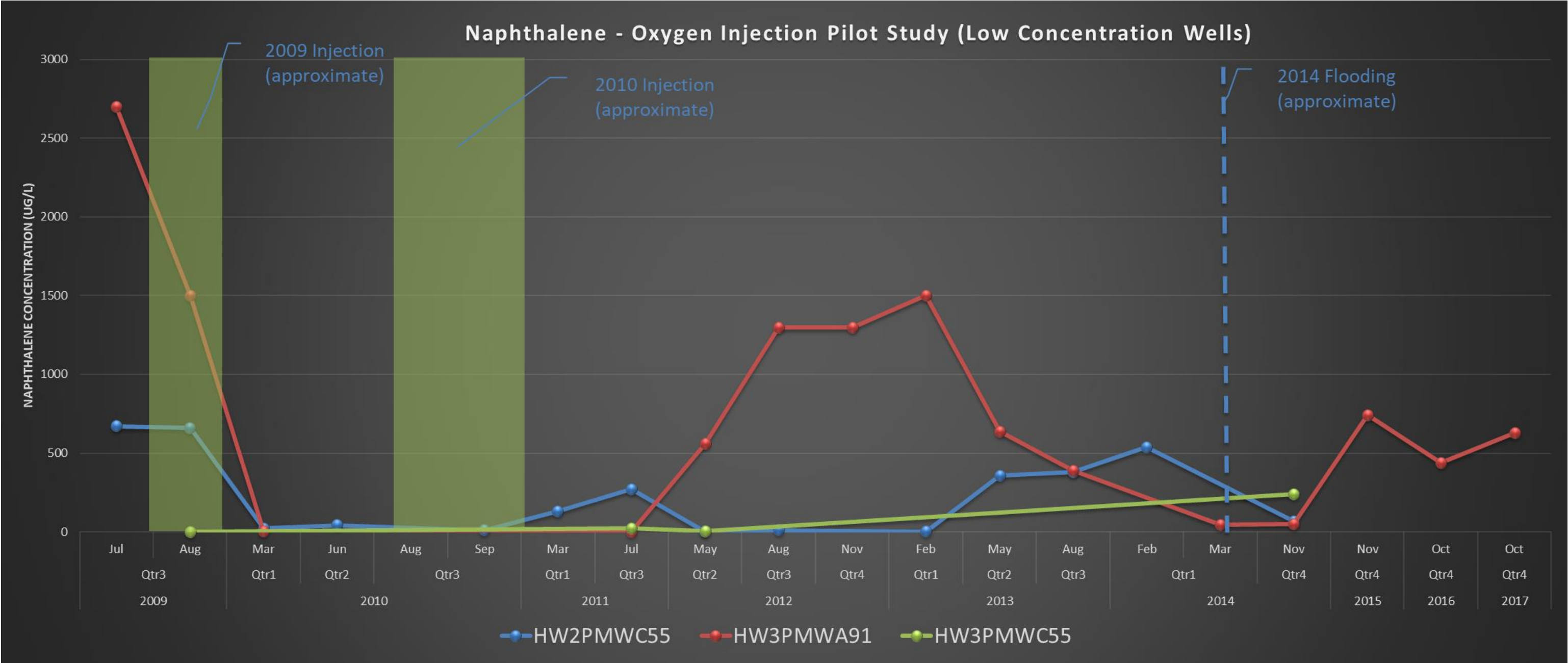


Figure B-8 Naphthalene in Low Concentration Wells from Oxygen Injection Pilot Study

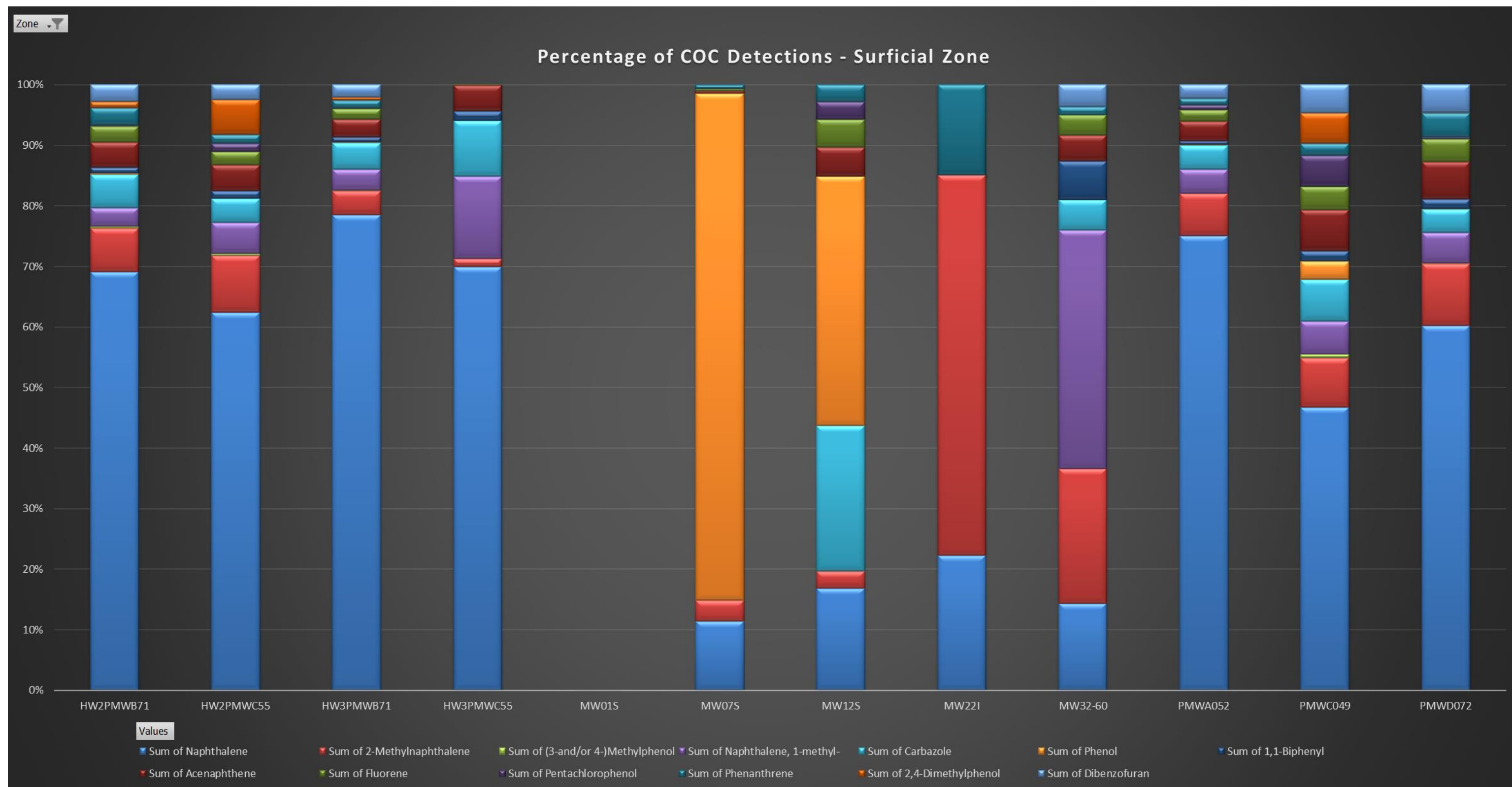


Figure B-9 Percentage of COC Detections – Surficial Zone

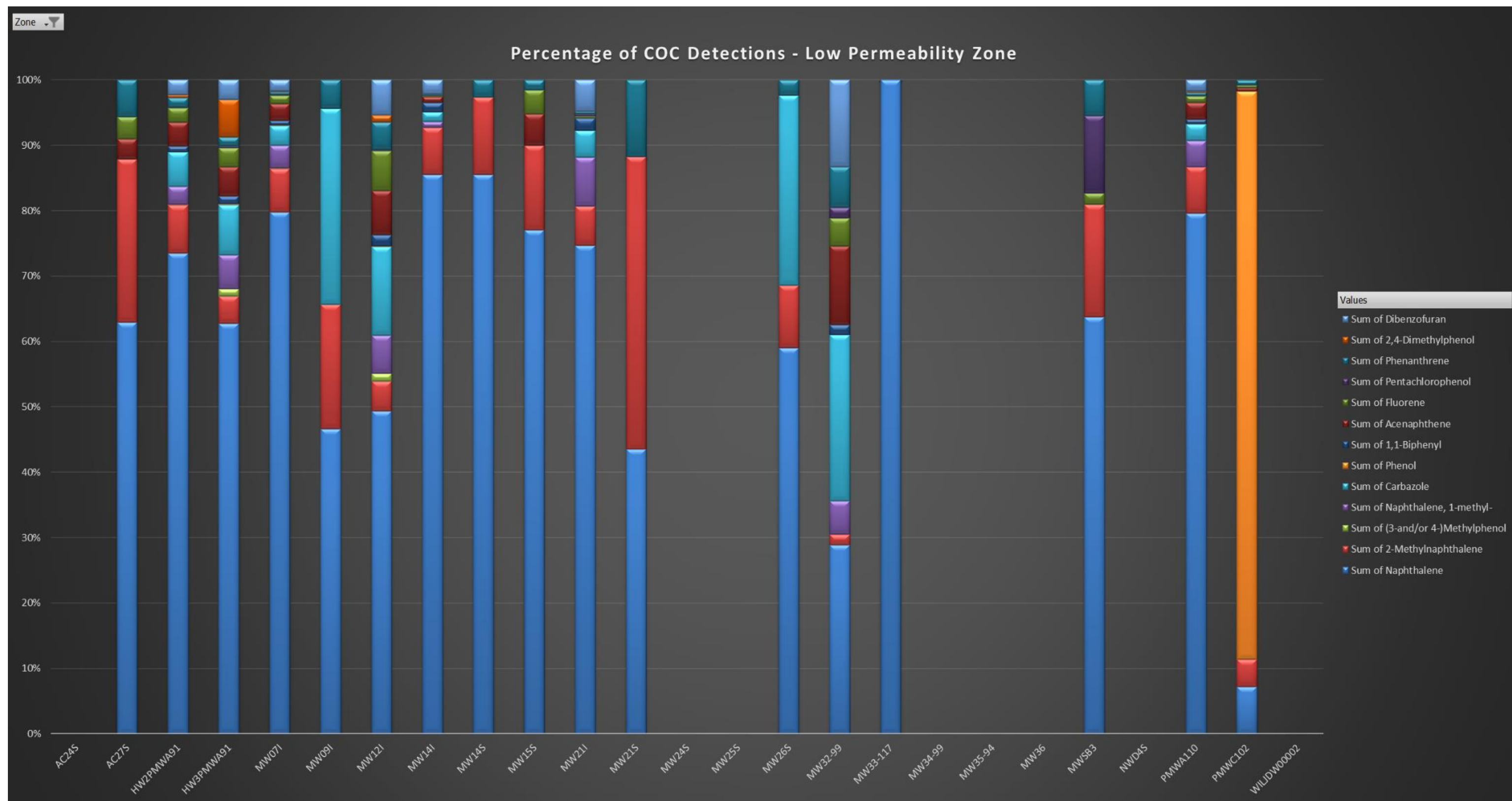


Figure B-10 Percentage of COC Detections – Low Permeability Zone

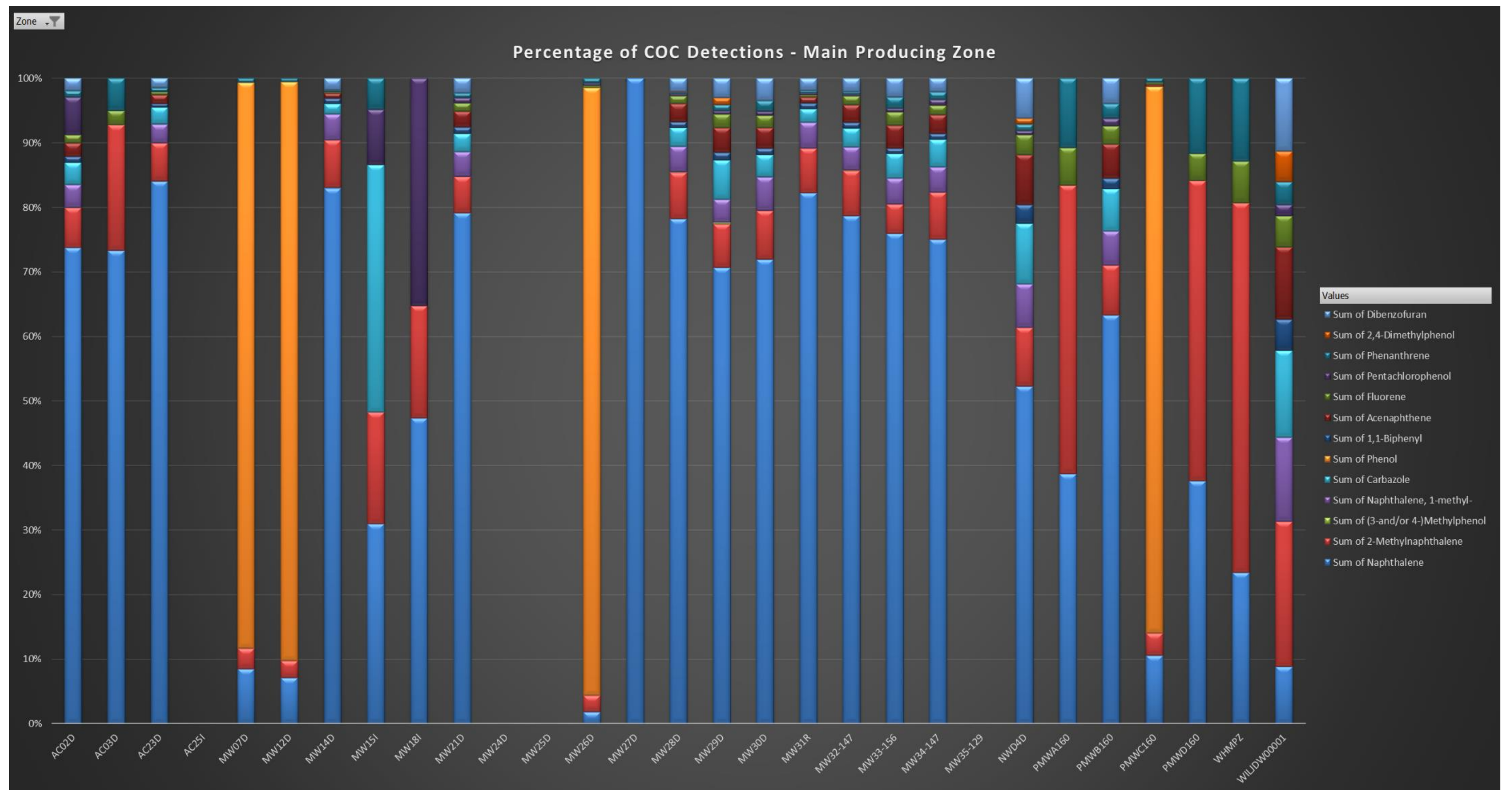


Figure B-11 Percentage of COC Detections – Main Producing Zone



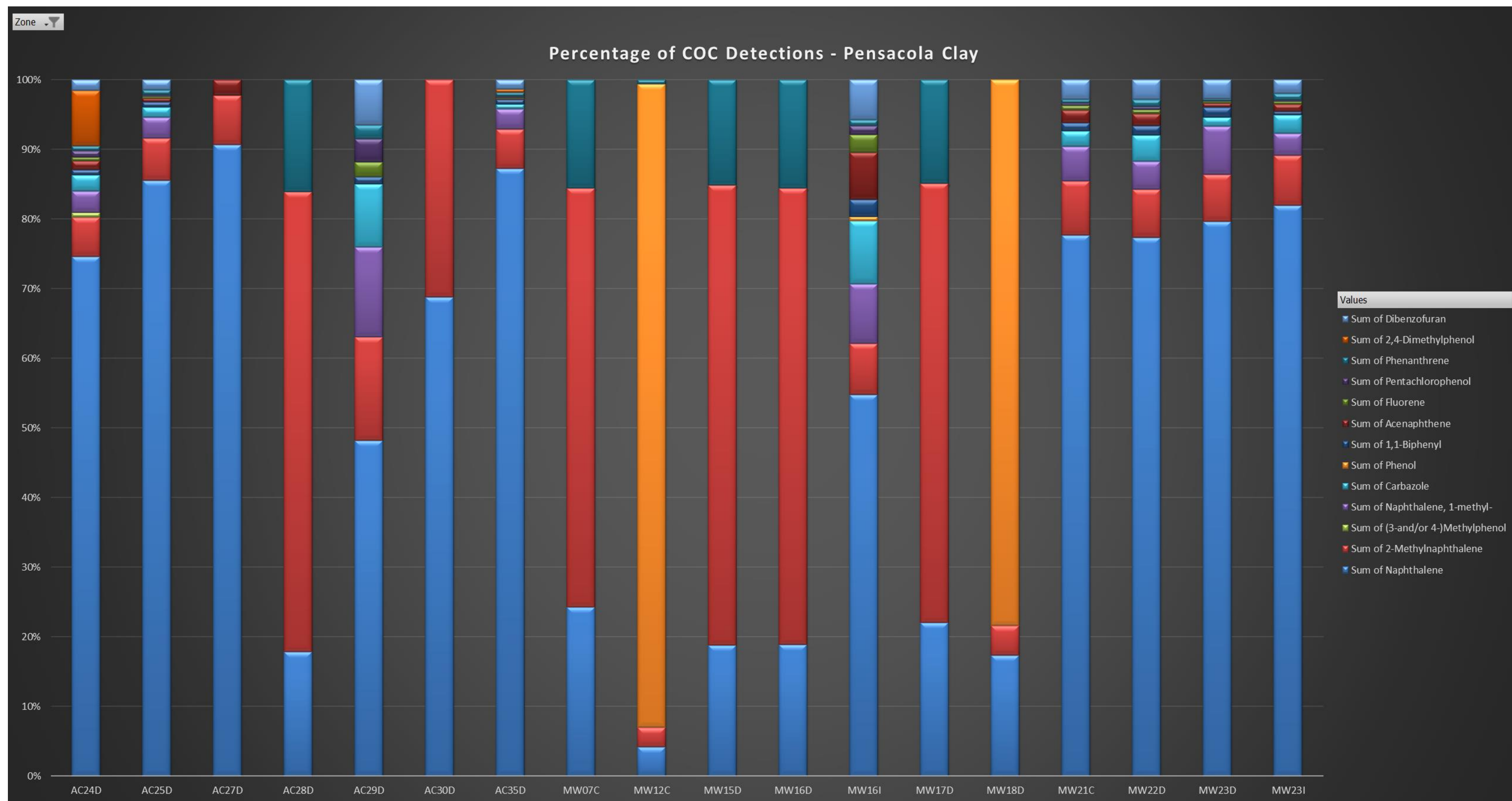


Figure B-12 Percentage of COC Detections – Pensacola Clay

# Mann-Kendall Trend Analysis

Well Name	Aquifer Zone	Distance from SWMU10	Number Values Reported (n)	Minimum Naphthalene Concentration (ug/L)	Maximum Naphthalene Concentration (ug/L)	Mean Naphthalene Concentration (ug/L)	MK Test Value (S)	Trend
AC02D	MPZ	2,856	13	2.0	870.0	288.0	-39.0	Decreasing
AC29D	PC	5,801	10	1.0	47.0	7.5	-27.0	Decreasing
HW2PMWB71	SZ	454	18	710.0	15,000.0	5,751.0	-65.0	Decreasing
HW2PMWC55	SZ	457	18	0.8	670.0	176.7	-37.0	Decreasing
NWD4D	MPZ	5,457	10	6.6	2,500.0	550.2	-38.0	Decreasing
PMWC049	SZ	224	12	2.1	2,200.0	439.3	-35.0	Decreasing
HW3PMWB71	SZ	602	19	1.0	8,800.0	2,129.0	53.0	Increasing
MW21C	PC	4,128	17	0.8	1,800.0	783.7	79.0	Increasing
MW26D	MPZ	8,562	8	0.5	2.0	1.3	18.0	Increasing
MW28D	MPZ	1,756	11	2,200.0	9,700.0	5,927.0	43.0	Increasing
MW30D	MPZ	4,433	14	0.1	1,100.0	209.4	83.0	Increasing
AC24S	LPZ	6,023	2	1.0	2.0	1.5	0.0	Insufficient Data
AC25I	MPZ	7,198	2	1.0	2.1	1.6	0.0	Insufficient Data
MW01S	SZ	432	2	2.0	2.0	2.0	0.0	Insufficient Data
MW24D	MPZ	7,067	2	2.0	2.0	2.0	0.0	Insufficient Data
MW24S	LPZ	7,070	2	2.1	2.1	2.1	0.0	Insufficient Data
MW25D	MPZ	7,776	2	2.0	2.1	2.1	0.0	Insufficient Data
MW25S	LPZ	7,789	2	2.0	2.1	2.1	0.0	Insufficient Data
NWD4S	LPZ	5,463	2	1.0	2.0	1.5	0.0	Insufficient Data
AC03D	MPZ	4,459	8	0.3	5.9	1.9	-4.0	No Trend
AC23D	MPZ	4,830	12	340.0	1,600.0	750.0	-10.0	No Trend
AC24D	PC	6,030	16	0.3	820.0	271.3	-9.0	No Trend
AC25D	PC	7,199	12	1.0	740.0	454.4	-15.0	No Trend
AC27D	PC	8,686	6	1.0	4.0	2.1	1.0	No Trend
AC27S	LPZ	8,692	3	0.8	4.1	2.3	1.0	No Trend
AC28D	PC	7,798	8	0.2	2.2	1.4	-8.0	No Trend
AC30D	PC	6,654	7	0.2	2.1	1.3	-7.0	No Trend
AC35D	PC	7,833	12	88.0	340.0	268.3	8.0	No Trend
HW2PMWA91	LPZ	446	21	5.6	23,000.0	6,316.0	-51.0	No Trend
HW3PMWA91	LPZ	594	19	1.0	2,900.0	763.5	-4.0	No Trend
HW3PMWC55	SZ	605	18	1.0	240.0	16.6	-1.0	No Trend
MW07C	PC	55	7	0.3	4.8	1.8	-8.0	No Trend
MW07D	MPZ	45	7	1.0	4.8	2.1	-6.0	No Trend
MW07I	LPZ	34	20	7,500.0	27,000.0	14,030.0	-23.0	No Trend
MW07S	SZ	23	8	1.0	6.3	2.4	-4.0	No Trend
MW09I	LPZ	417	8	0.3	3.4	1.6	-9.0	No Trend
MW12C	PC	864	7	0.4	5.0	1.9	-10.0	No Trend
MW12D	MPZ	864	7	1.0	5.0	2.1	-4.0	No Trend
MW12I	LPZ	846	13	270.0	2,300.0	717.7	-14.0	No Trend
MW12S	SZ	854	6	1.0	5.0	1.8	-2.0	No Trend

# Mann-Kendall Trend Analysis

Well Name	Aquifer Zone	Distance from SWMU10	Number Values Reported (n)	Minimum Naphthalene Concentration (ug/L)	Maximum Naphthalene Concentration (ug/L)	Mean Naphthalene Concentration (ug/L)	MK Test Value (S)	Trend
MW14D	MPZ	2,550	16	220.0	1,700.0	833.8	4.0	No Trend
MW14I	LPZ	2,557	13	0.4	1,500.0	241.9	-7.0	No Trend
MW14S	LPZ	2,533	8	0.5	11.0	2.6	2.0	No Trend
MW15D	PC	5,274	6	0.2	2.1	1.2	-2.0	No Trend
MW15I	MPZ	5,287	6	0.1	2.1	1.3	0.0	No Trend
MW15S	LPZ	5,264	5	1.0	7.1	2.6	1.0	No Trend
MW16D	PC	5,885	7	0.2	5.0	1.8	-8.0	No Trend
MW16I	PC	5,877	15	1.0	550.0	146.7	0.0	No Trend
MW17D	PC	6,641	7	0.3	5.0	1.8	-8.0	No Trend
MW18D	PC	5,300	7	0.5	5.0	1.8	-8.0	No Trend
MW18I	MPZ	5,273	6	0.3	2.0	1.2	-1.0	No Trend
MW21D	MPZ	4,136	22	0.1	530.0	226.1	-3.0	No Trend
MW21I	LPZ	2,549	8	0.2	340.0	43.8	0.0	No Trend
MW21S	LPZ	4,121	6	0.7	2.2	1.3	0.0	No Trend
MW22D	PC	2,555	11	0.3	1,900.0	291.2	12.0	No Trend
MW22I	SZ	2,557	8	0.3	5.0	1.8	2.0	No Trend
MW23D	PC	7,068	10	1.0	690.0	71.0	-10.0	No Trend
MW23I	PC	7,126	12	2.1	2,000.0	906.0	-17.0	No Trend
MW26S	LPZ	8,566	4	0.3	8.6	3.3	2.0	No Trend
MW27D	MPZ	705	14	0.1	8.5	2.4	11.0	No Trend
MW29D	MPZ	1,839	9	45.0	6,000.0	2,666.0	-4.0	No Trend
MW31R	MPZ	6,364	3	270.0	550.0	370.0	-3.0	No Trend
MW32-147	MPZ	1,068	3	10,000.0	10,000.0	10,000.0	0.0	No Trend
MW32-60	SZ	1,063	3	4.6	13.0	9.9	-1.0	No Trend
MW32-99	LPZ	1,066	4	2.0	53.0	29.8	-4.0	No Trend
MW33-117	LPZ	1,666	3	1.2	2.1	1.8	-3.0	No Trend
MW33-156	MPZ	1,669	3	180.0	240.0	213.3	1.0	No Trend
MW34-147	MPZ	2,065	3	1,100.0	2,000.0	1,467.0	3.0	No Trend
MW34-99	LPZ	2,073	3	2.0	2.1	2.1	0.0	No Trend
MW35-129	MPZ	5,815	3	2.0	2.1	2.1	-2.0	No Trend
MW35-94	LPZ	5,815	3	2.0	2.0	2.0	0.0	No Trend
MW36	LPZ	6,648	3	2.0	2.3	2.1	-1.0	No Trend
MWSB3	LPZ	12	6	0.4	6.8	2.4	2.0	No Trend
PMWA052	SZ	15	13	4,700.0	14,000.0	9,108.0	20.0	No Trend
PMWA110	LPZ	2	13	1,700.0	20,000.0	11,277.0	4.0	No Trend
PMWA160	MPZ	1	10	0.4	2.1	1.5	8.0	No Trend
PMWB160	MPZ	8	16	0.3	660.0	68.1	3.0	No Trend
PMWC102	LPZ	233	11	0.5	5.1	2.1	3.0	No Trend
PMWC160	MPZ	217	10	1.0	5.2	2.3	4.0	No Trend
PMWD072	SZ	16	19	18.0	7,800.0	2,567.0	-46.0	No Trend



## Mann-Kendall Trend Analysis

Well Name	Aquifer Zone	Distance from SWMU10	Number Values Reported (n)	Minimum Naphthalene Concentration (ug/L)	Maximum Naphthalene Concentration (ug/L)	Mean Naphthalene Concentration (ug/L)	MK Test Value (S)	Trend
PMWD160	MPZ	9	10	0.3	4.7	1.9	0.0	No Trend
WHMPZ	MPZ	2,953	6	0.4	2.0	1.2	-1.0	No Trend
WILJDW00001	MPZ	3,057	3	1.1	51.0	18.0	-3.0	No Trend
WILJDW00002	LPZ	3,060	3	1.9	2.1	2.0	-1.0	No Trend

Notes: Data covers from 2007 to 2017

Trend analysis completed with ProUCL V5.1, 95% Confidence Coefficient

MK = Mann-Kendall

ug/L = micrograms per liter

Decreasing = statistically significant evidence of a decreasing trend at the specified level of significance

Increasing = statistically significant evidence of an increasing trend at the specified level of significance

LPZ = Low-permeability Zone, MPZ = Main Producing Zone, PC = Pensacola Clay, SZ = Source Zone

Average Detections and Percent of All COC Detections

		COC Name	Pentachlorophenol			Carbazole			(3-and/or 4-)Methylphenol			Naphthalene		
		COC CAS#	87-86-5			86-74-8			1319-77-3			91-20-3		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
PMWA052	15	SZ	92.8	13 / 13 / 13	<div><div></div></div> 1%	480.8	13 / 13 / 13	<div><div></div></div> 4%	5.0	13 / 8 / 5	<div><div></div></div> 0%	9107.7	13 / 13 / 13	<div><div></div></div> 75%
MW12S	854	SZ	0.2	6 / 1 / 0	<div><div></div></div> 3%	1.4	6 / 1 / 0	<div><div></div></div> 24%		6 / 0 / 0	<div><div></div></div> 0%	1.0	6 / 1 / 0	<div><div></div></div> 17%
PMWC049	224	SZ	52.7	12 / 11 / 11	<div><div></div></div> 5%	71.1	12 / 11 / 10	<div><div></div></div> 7%	6.4	12 / 5 / 2	<div><div></div></div> 1%	479.0	12 / 11 / 10	<div><div></div></div> 47%
MW01S	432	SZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
HW3PMWC55	605	SZ		18 / 0 / 0	<div><div></div></div> 0%	8.9	17 / 2 / 2	<div><div></div></div> 9%		17 / 0 / 0	<div><div></div></div> 0%	67.2	18 / 4 / 2	<div><div></div></div> 70%
HW2PMWC55	457	SZ	4.9	18 / 8 / 7	<div><div></div></div> 1%	14.4	17 / 15 / 12	<div><div></div></div> 4%	1.4	17 / 2 / 0	<div><div></div></div> 0%	226.4	18 / 14 / 12	<div><div></div></div> 62%
MW07S	23	SZ		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%	4.0	8 / 3 / 0	<div><div></div></div> 11%
MW32-60	1063	SZ		3 / 0 / 0	<div><div></div></div> 0%	3.5	3 / 2 / 2	<div><div></div></div> 5%		3 / 0 / 0	<div><div></div></div> 0%	9.9	3 / 3 / 2	<div><div></div></div> 14%
MW22I	2557	SZ		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%	0.3	8 / 1 / 0	<div><div></div></div> 22%
PMWD072	16	SZ	14.7	19 / 19 / 19	<div><div></div></div> 0%	162.9	19 / 19 / 19	<div><div></div></div> 4%	3.3	19 / 6 / 3	<div><div></div></div> 0%	2567.3	19 / 19 / 19	<div><div></div></div> 60%
HW3PMWB71	602	SZ	2.7	19 / 8 / 6	<div><div></div></div> 0%	151.1	18 / 15 / 15	<div><div></div></div> 4%	1.9	18 / 2 / 0	<div><div></div></div> 0%	2696.3	19 / 15 / 15	<div><div></div></div> 78%
HW2PMWB71	454	SZ	11.8	18 / 15 / 14	<div><div></div></div> 0%	458.8	17 / 17 / 17	<div><div></div></div> 6%	23.9	17 / 15 / 15	<div><div></div></div> 0%	5750.6	18 / 18 / 18	<div><div></div></div> 69%
MW14S	2533	LPZ		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%	5.7	8 / 2 / 1	<div><div></div></div> 86%
WILJDW00002	3060	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW21S	4121	LPZ		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%	0.7	6 / 1 / 0	<div><div></div></div> 44%
AC24S	6023	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
HW3PMWA91	594	LPZ	4.5	19 / 13 / 11	<div><div></div></div> 0%	110.2	18 / 15 / 15	<div><div></div></div> 8%	16.8	18 / 4 / 3	<div><div></div></div> 1%	906.4	19 / 16 / 14	<div><div></div></div> 63%
HW2PMWA91	446	LPZ	5.8	21 / 18 / 17	<div><div></div></div> 0%	454.0	19 / 19 / 19	<div><div></div></div> 5%	7.3	19 / 17 / 15	<div><div></div></div> 0%	6315.7	21 / 21 / 20	<div><div></div></div> 73%
MW36	6648	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW34-99	2073	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW32-99	1066	LPZ	2.2	4 / 3 / 3	<div><div></div></div> 2%	34.3	4 / 4 / 4	<div><div></div></div> 25%		4 / 0 / 0	<div><div></div></div> 0%	39.0	4 / 3 / 3	<div><div></div></div> 29%
MWSB3	12	LPZ	0.7	6 / 1 / 0	<div><div></div></div> 12%		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%	3.6	6 / 2 / 0	<div><div></div></div> 64%
MW25S	7789	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW26S	8566	LPZ		4 / 0 / 0	<div><div></div></div> 0%	2.2	4 / 1 / 1	<div><div></div></div> 29%		4 / 0 / 0	<div><div></div></div> 0%	4.5	4 / 2 / 0	<div><div></div></div> 59%
AC27S	8692	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%	2.4	3 / 2 / 0	<div><div></div></div> 63%
NWD4S	5463	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW14I	2557	LPZ	0.1	13 / 1 / 0	<div><div></div></div> 0%	13.8	13 / 3 / 3	<div><div></div></div> 2%		13 / 0 / 0	<div><div></div></div> 0%	782.6	13 / 4 / 3	<div><div></div></div> 86%
PMWC102	233	LPZ		11 / 0 / 0	<div><div></div></div> 0%		11 / 0 / 0	<div><div></div></div> 0%		11 / 0 / 0	<div><div></div></div> 0%	2.4	11 / 4 / 0	<div><div></div></div> 7%
PMWA110	2	LPZ	4.4	13 / 8 / 7	<div><div></div></div> 0%	356.9	13 / 13 / 13	<div><div></div></div> 3%	8.8	13 / 8 / 7	<div><div></div></div> 0%	11276.9	13 / 13 / 13	<div><div></div></div> 79%
MW21I	2549	LPZ	0.7	8 / 1 / 0	<div><div></div></div> 0%	9.3	8 / 1 / 1	<div><div></div></div> 4%		8 / 0 / 0	<div><div></div></div> 0%	170.1	8 / 2 / 1	<div><div></div></div> 75%
MW24S	7070	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW09I	417	LPZ		8 / 0 / 0	<div><div></div></div> 0%	1.1	8 / 1 / 0	<div><div></div></div> 30%		8 / 0 / 0	<div><div></div></div> 0%	1.7	8 / 4 / 0	<div><div></div></div> 47%
MW35-94	5815	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW12I	846	LPZ	2.8	13 / 12 / 10	<div><div></div></div> 0%	197.5	13 / 13 / 13	<div><div></div></div> 14%	17.5	13 / 2 / 1	<div><div></div></div> 1%	717.7	13 / 13 / 13	<div><div></div></div> 49%
MW07I	34	LPZ	6.2	20 / 17 / 17	<div><div></div></div> 0%	535.5	20 / 20 / 20	<div><div></div></div> 3%	11.2	20 / 7 / 6	<div><div></div></div> 0%	14030.0	20 / 20 / 20	<div><div></div></div> 80%
MW15S	5264	LPZ		5 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%	7.1	5 / 1 / 0	<div><div></div></div> 77%
MW33-117	1666	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%	1.2	3 / 1 / 0	<div><div></div></div> 100%

Average Detections and Percent of All COC Detections

		COC Name	Pentachlorophenol			Carbazole			(3-and/or 4-)Methylphenol			Naphthalene		
		COC CAS#	87-86-5			86-74-8			1319-77-3			91-20-3		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
MW29D	1839	MPZ	17.6	9 / 7 / 7	<div><div></div></div> 0%	232.6	9 / 9 / 9	<div><div></div></div> 6%	9.3	9 / 5 / 5	<div><div></div></div> 0%	2666.1	9 / 9 / 9	<div><div></div></div> 70%
AC02D	2856	MPZ	32.8	13 / 9 / 9	<div><div></div></div> 6%	19.3	13 / 9 / 9	<div><div></div></div> 3%		13 / 0 / 0	<div><div></div></div> 0%	415.1	13 / 9 / 9	<div><div></div></div> 74%
MW35-129	5815	MPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW34-147	2065	MPZ	18.7	3 / 3 / 3	<div><div></div></div> 1%	83.0	3 / 3 / 3	<div><div></div></div> 4%		3 / 0 / 0	<div><div></div></div> 0%	1466.7	3 / 3 / 3	<div><div></div></div> 75%
MW32-147	1068	MPZ	37.7	3 / 3 / 3	<div><div></div></div> 0%	370.0	3 / 3 / 3	<div><div></div></div> 3%	9.0	3 / 1 / 1	<div><div></div></div> 0%	10000.0	3 / 3 / 3	<div><div></div></div> 79%
MW21D	4136	MPZ	2.6	22 / 19 / 18	<div><div></div></div> 1%	8.8	22 / 19 / 18	<div><div></div></div> 3%		22 / 0 / 0	<div><div></div></div> 0%	248.7	22 / 20 / 18	<div><div></div></div> 79%
MW33-156	1669	MPZ	1.6	3 / 2 / 2	<div><div></div></div> 1%	10.6	3 / 3 / 3	<div><div></div></div> 4%		3 / 0 / 0	<div><div></div></div> 0%	213.3	3 / 3 / 3	<div><div></div></div> 76%
PMWB160	8	MPZ	2.2	16 / 2 / 2	<div><div></div></div> 1%	12.5	16 / 7 / 7	<div><div></div></div> 7%		16 / 0 / 0	<div><div></div></div> 0%	119.8	16 / 9 / 8	<div><div></div></div> 63%
MW15I	5287	MPZ	0.3	6 / 1 / 0	<div><div></div></div> 9%	1.2	6 / 1 / 0	<div><div></div></div> 38%		6 / 0 / 0	<div><div></div></div> 0%	1.0	6 / 2 / 0	<div><div></div></div> 31%
PMWA160	1	MPZ		10 / 0 / 0	<div><div></div></div> 0%		10 / 0 / 0	<div><div></div></div> 0%		10 / 0 / 0	<div><div></div></div> 0%	0.9	10 / 3 / 0	<div><div></div></div> 39%
AC25I	7198	MPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW28D	1756	MPZ	22.4	11 / 11 / 11	<div><div></div></div> 0%	222.5	11 / 11 / 11	<div><div></div></div> 3%	2.3	11 / 2 / 0	<div><div></div></div> 0%	5927.3	11 / 11 / 11	<div><div></div></div> 78%
PMWD160	9	MPZ		10 / 0 / 0	<div><div></div></div> 0%		10 / 0 / 0	<div><div></div></div> 0%		10 / 0 / 0	<div><div></div></div> 0%	1.0	10 / 2 / 0	<div><div></div></div> 38%
MW18I	5273	MPZ	0.2	6 / 3 / 0	<div><div></div></div> 35%		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%	0.3	6 / 1 / 0	<div><div></div></div> 47%
PMWC160	217	MPZ		10 / 0 / 0	<div><div></div></div> 0%		10 / 0 / 0	<div><div></div></div> 0%		10 / 0 / 0	<div><div></div></div> 0%	3.4	10 / 3 / 0	<div><div></div></div> 11%
AC03D	4459	MPZ		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%	3.1	8 / 2 / 0	<div><div></div></div> 65%
WILJDW00001	3057	MPZ	3.7	3 / 2 / 2	<div><div></div></div> 2%	27.6	3 / 3 / 3	<div><div></div></div> 14%		3 / 0 / 0	<div><div></div></div> 0%	18.0	3 / 3 / 1	<div><div></div></div> 9%
MW30D	4433	MPZ	1.9	14 / 3 / 3	<div><div></div></div> 1%	10.7	14 / 8 / 5	<div><div></div></div> 3%		14 / 0 / 0	<div><div></div></div> 0%	225.4	14 / 13 / 10	<div><div></div></div> 72%
WHMPZ	2953	MPZ		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%	0.4	6 / 1 / 0	<div><div></div></div> 23%
NWD4D	5457	MPZ	6.9	10 / 10 / 10	<div><div></div></div> 1%	98.7	10 / 10 / 10	<div><div></div></div> 9%		10 / 0 / 0	<div><div></div></div> 0%	550.2	10 / 10 / 7	<div><div></div></div> 52%
AC23D	4830	MPZ	0.3	12 / 3 / 0	<div><div></div></div> 0%	23.4	12 / 12 / 12	<div><div></div></div> 3%		12 / 0 / 0	<div><div></div></div> 0%	750.0	12 / 12 / 12	<div><div></div></div> 84%
MW07D	45	MPZ		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	2.6	7 / 1 / 0	<div><div></div></div> 8%
MW12D	864	MPZ		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	2.6	7 / 1 / 0	<div><div></div></div> 7%
MW24D	7067	MPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW27D	705	MPZ		14 / 0 / 0	<div><div></div></div> 0%		14 / 0 / 0	<div><div></div></div> 0%		14 / 0 / 0	<div><div></div></div> 0%	3.1	14 / 3 / 0	<div><div></div></div> 100%
MW25D	7776	MPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW31R	6364	MPZ	1.4	3 / 2 / 1	<div><div></div></div> 0%	9.7	3 / 3 / 3	<div><div></div></div> 2%		3 / 0 / 0	<div><div></div></div> 0%	370.0	3 / 3 / 3	<div><div></div></div> 82%
MW14D	2550	MPZ	1.0	16 / 9 / 4	<div><div></div></div> 0%	15.8	16 / 16 / 16	<div><div></div></div> 2%		16 / 0 / 0	<div><div></div></div> 0%	833.8	16 / 16 / 16	<div><div></div></div> 83%
MW26D	8562	MPZ	0.1	8 / 1 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%	0.6	8 / 2 / 0	<div><div></div></div> 2%
MW23I	7126	PC	2.1	12 / 11 / 11	<div><div></div></div> 0%	29.1	12 / 12 / 12	<div><div></div></div> 3%		12 / 0 / 0	<div><div></div></div> 0%	906.0	12 / 12 / 11	<div><div></div></div> 82%
MW16I	5877	PC	3.8	15 / 12 / 11	<div><div></div></div> 1%	27.8	15 / 13 / 13	<div><div></div></div> 9%		15 / 0 / 0	<div><div></div></div> 0%	169.1	15 / 13 / 13	<div><div></div></div> 55%
MW22D	2555	PC	3.6	11 / 3 / 3	<div><div></div></div> 0%	30.7	11 / 4 / 3	<div><div></div></div> 4%		11 / 0 / 0	<div><div></div></div> 0%	638.3	11 / 5 / 4	<div><div></div></div> 77%
MW21C	4128	PC	3.8	17 / 15 / 12	<div><div></div></div> 0%	23.3	17 / 17 / 17	<div><div></div></div> 2%		17 / 0 / 0	<div><div></div></div> 0%	832.6	17 / 16 / 14	<div><div></div></div> 78%
MW12C	864	PC		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	1.0	7 / 2 / 0	<div><div></div></div> 4%
AC30D	6654	PC		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	0.2	7 / 1 / 0	<div><div></div></div> 69%
AC28D	7798	PC		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%	0.2	8 / 1 / 0	<div><div></div></div> 18%
MW07C	55	PC		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	0.3	7 / 1 / 0	<div><div></div></div> 24%
AC29D	5801	PC	0.5	10 / 2 / 0	<div><div></div></div> 3%	1.4	10 / 1 / 0	<div><div></div></div> 9%		10 / 0 / 0	<div><div></div></div> 0%	7.5	10 / 10 / 1	<div><div></div></div> 48%
AC27D	8686	PC		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%	4.0	6 / 1 / 0	<div><div></div></div> 91%
AC35D	7833	PC	0.6	12 / 4 / 1	<div><div></div></div> 0%	2.0	12 / 12 / 11	<div><div></div></div> 1%		12 / 0 / 0	<div><div></div></div> 0%	268.3	12 / 12 / 12	<div><div></div></div> 87%
AC24D	6030	PC	3.4	16 / 14 / 12	<div><div></div></div> 1%	8.4	16 / 16 / 16	<div><div></div></div> 2%	2.4	16 / 1 / 0	<div><div></div></div> 1%	271.3	16 / 16 / 15	<div><div></div></div> 75%
AC25D	7199	PC	1.2	12 / 7 / 4	<div><div></div></div> 0%	7.7	12 / 12 / 12	<div><div></div></div> 1%		12 / 0 / 0	<div><div></div></div> 0%	454.4	12 / 12 / 11	<div><div></div></div> 86%
MW15D	5274	PC		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%	0.2	6 / 1 / 0	<div><div></div></div> 19%
MW18D	5300	PC		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	0.5	7 / 1 / 0	<div><div></div></div> 17%
MW16D	5885	PC		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	0.2	7 / 1 / 0	<div><div></div></div> 19%
MW23D	7068	PC	0.3	10 / 2 / 0	<div><div></div></div> 0%	5.9	10 / 2 / 2	<div><div></div></div> 1%		10 / 0 / 0	<div><div></div></div> 0%	346.6	10 / 2 / 1	<div><div></div></div> 80%
MW17D	6641	PC		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%	0.3	7 / 1 / 0	<div><div></div></div> 22%



Average Detections and Percent of All COC Detections

		COC Name	2-Methylnaphthalene			Dibenzofuran			Naphthalene, 1-methyl-			2,4-Dimethylphenol		
		COC CAS#	91-57-6			132-64-9			90-12-0			105-67-9		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
PMWA052	15	SZ	848.5	13 / 13 / 13	<div><div></div></div> 7%	268.6	13 / 11 / 11	<div><div></div></div> 2%	479.1	11 / 11 / 11	<div><div></div></div> 4%	4.6	13 / 4 / 0	<div><div></div></div> 0%
MW12S	854	SZ	0.2	6 / 1 / 0	<div><div></div></div> 3%		6 / 0 / 0	<div><div></div></div> 0%		4 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%
PMWC049	224	SZ	82.5	12 / 10 / 9	<div><div></div></div> 8%	47.7	12 / 11 / 7	<div><div></div></div> 5%	56.1	12 / 11 / 7	<div><div></div></div> 5%	51.5	12 / 7 / 1	<div><div></div></div> 5%
MW01S	432	SZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
HW3PMWC55	605	SZ	1.3	18 / 2 / 0	<div><div></div></div> 1%		17 / 0 / 0	<div><div></div></div> 0%	13.0	14 / 1 / 0	<div><div></div></div> 14%		17 / 0 / 0	<div><div></div></div> 0%
HW2PMWC55	457	SZ	34.2	18 / 10 / 8	<div><div></div></div> 9%	9.0	17 / 14 / 1	<div><div></div></div> 2%	18.4	17 / 11 / 3	<div><div></div></div> 5%	21.0	17 / 4 / 0	<div><div></div></div> 6%
MW07S	23	SZ	1.2	8 / 1 / 0	<div><div></div></div> 3%		8 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%
MW32-60	1063	SZ	15.2	3 / 3 / 2	<div><div></div></div> 22%	2.5	3 / 3 / 0	<div><div></div></div> 4%	27.0	3 / 3 / 1	<div><div></div></div> 39%		3 / 0 / 0	<div><div></div></div> 0%
MW22I	2557	SZ	0.8	8 / 1 / 0	<div><div></div></div> 63%		8 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%
PMWD072	16	SZ	436.4	19 / 19 / 18	<div><div></div></div> 10%	194.9	19 / 18 / 18	<div><div></div></div> 5%	216.6	17 / 17 / 17	<div><div></div></div> 5%	2.2	19 / 2 / 0	<div><div></div></div> 0%
HW3PMWB71	602	SZ	136.9	19 / 14 / 13	<div><div></div></div> 4%	72.3	18 / 14 / 12	<div><div></div></div> 2%	119.1	17 / 14 / 13	<div><div></div></div> 3%	15.0	18 / 9 / 0	<div><div></div></div> 0%
HW2PMWB71	454	SZ	602.8	18 / 18 / 18	<div><div></div></div> 7%	232.1	17 / 17 / 17	<div><div></div></div> 3%	258.2	17 / 17 / 17	<div><div></div></div> 3%	86.4	17 / 15 / 3	<div><div></div></div> 1%
MW14S	2533	LPZ	0.8	8 / 2 / 0	<div><div></div></div> 12%		8 / 0 / 0	<div><div></div></div> 0%		7 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%
WILJDW00002	3060	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW21S	4121	LPZ	0.8	6 / 1 / 0	<div><div></div></div> 45%		6 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%
AC24S	6023	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
HW3PMWA91	594	LPZ	60.2	19 / 15 / 12	<div><div></div></div> 4%	43.8	18 / 15 / 11	<div><div></div></div> 3%	74.6	17 / 14 / 12	<div><div></div></div> 5%	82.7	18 / 11 / 3	<div><div></div></div> 6%
HW2PMWA91	446	LPZ	631.2	21 / 20 / 20	<div><div></div></div> 7%	199.7	19 / 18 / 18	<div><div></div></div> 2%	235.1	19 / 17 / 17	<div><div></div></div> 3%	31.6	19 / 17 / 0	<div><div></div></div> 0%
MW36	6648	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW34-99	2073	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW32-99	1066	LPZ	2.2	4 / 1 / 0	<div><div></div></div> 2%	18.0	4 / 4 / 0	<div><div></div></div> 13%	7.0	4 / 4 / 0	<div><div></div></div> 5%		4 / 0 / 0	<div><div></div></div> 0%
MWSB3	12	LPZ	1.0	6 / 2 / 0	<div><div></div></div> 17%		6 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%		6 / 0 / 0	<div><div></div></div> 0%
MW25S	7789	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW26S	8566	LPZ	0.7	4 / 1 / 0	<div><div></div></div> 10%		4 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		4 / 0 / 0	<div><div></div></div> 0%
AC27S	8692	LPZ	1.0	3 / 1 / 0	<div><div></div></div> 25%		3 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
NWD4S	5463	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW14I	2557	LPZ	65.8	13 / 4 / 3	<div><div></div></div> 7%	19.7	13 / 3 / 1	<div><div></div></div> 2%	8.0	10 / 1 / 0	<div><div></div></div> 1%		13 / 0 / 0	<div><div></div></div> 0%
PMWC102	233	LPZ	1.4	11 / 1 / 0	<div><div></div></div> 4%		11 / 0 / 0	<div><div></div></div> 0%		9 / 0 / 0	<div><div></div></div> 0%		11 / 0 / 0	<div><div></div></div> 0%
PMWA110	2	LPZ	996.9	13 / 13 / 13	<div><div></div></div> 7%	246.9	13 / 13 / 13	<div><div></div></div> 2%	568.0	10 / 10 / 10	<div><div></div></div> 4%	23.5	13 / 9 / 0	<div><div></div></div> 0%
MW21I	2549	LPZ	13.6	8 / 2 / 1	<div><div></div></div> 6%	11.0	8 / 1 / 0	<div><div></div></div> 5%	17.0	7 / 1 / 0	<div><div></div></div> 7%		8 / 0 / 0	<div><div></div></div> 0%
MW24S	7070	LPZ		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%		2 / 0 / 0	<div><div></div></div> 0%
MW09I	417	LPZ	0.7	8 / 1 / 0	<div><div></div></div> 19%		8 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%		8 / 0 / 0	<div><div></div></div> 0%
MW35-94	5815	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%
MW12I	846	LPZ	66.3	13 / 13 / 13	<div><div></div></div> 5%	78.3	13 / 13 / 13	<div><div></div></div> 5%	85.1	11 / 11 / 11	<div><div></div></div> 6%	15.3	13 / 10 / 0	<div><div></div></div> 1%
MW07I	34	LPZ	1171.0	20 / 20 / 20	<div><div></div></div> 7%	302.0	20 / 20 / 20	<div><div></div></div> 2%	605.0	16 / 16 / 16	<div><div></div></div> 3%	22.2	20 / 14 / 0	<div><div></div></div> 0%
MW15S	5264	LPZ	1.2	5 / 1 / 0	<div><div></div></div> 13%		5 / 0 / 0	<div><div></div></div> 0%		4 / 0 / 0	<div><div></div></div> 0%		5 / 0 / 0	<div><div></div></div> 0%
MW33-117	1666	LPZ		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%		3 / 0 / 0	<div><div></div></div> 0%

Average Detections and Percent of All COC Detections

		COC Name	2-Methylnaphthalene			Dibenzofuran			Naphthalene, 1-methyl-			2,4-Dimethylphenol		
		COC CAS#	91-57-6			132-64-9			90-12-0			105-67-9		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
MW29D	1839	MPZ	253.5	9 / 9 / 8	<div><div></div></div> 7%	113.0	9 / 9 / 7	<div><div></div></div> 3%	134.2	8 / 8 / 6	<div><div></div></div> 4%	41.0	9 / 5 / 0	<div><div></div></div> 1%
AC02D	2856	MPZ	34.9	13 / 9 / 6	<div><div></div></div> 6%	10.9	13 / 9 / 1	<div><div></div></div> 2%	19.8	10 / 5 / 2	<div><div></div></div> 4%		13 / 0 / 0	0%
MW35-129	5815	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%
MW34-147	2065	MPZ	143.3	3 / 3 / 3	<div><div></div></div> 7%	41.0	3 / 3 / 3	<div><div></div></div> 2%	76.7	3 / 3 / 3	<div><div></div></div> 4%		3 / 0 / 0	0%
MW32-147	1068	MPZ	890.0	3 / 3 / 3	<div><div></div></div> 7%	266.7	3 / 3 / 3	<div><div></div></div> 2%	456.7	3 / 3 / 3	<div><div></div></div> 4%		3 / 0 / 0	0%
MW21D	4136	MPZ	17.5	22 / 20 / 17	<div><div></div></div> 6%	7.3	22 / 18 / 0	<div><div></div></div> 2%	12.1	19 / 17 / 0	<div><div></div></div> 4%		22 / 0 / 0	0%
MW33-156	1669	MPZ	12.7	3 / 3 / 3	<div><div></div></div> 5%	8.1	3 / 3 / 0	<div><div></div></div> 3%	11.3	3 / 3 / 0	<div><div></div></div> 4%		3 / 0 / 0	0%
PMWB160	8	MPZ	14.6	16 / 9 / 4	<div><div></div></div> 8%	7.4	16 / 6 / 0	<div><div></div></div> 4%	10.0	14 / 6 / 1	<div><div></div></div> 5%		16 / 0 / 0	0%
MW15I	5287	MPZ	0.5	6 / 1 / 0	<div><div></div></div> 17%		6 / 0 / 0	0%		5 / 0 / 0	0%		6 / 0 / 0	0%
PMWA160	1	MPZ	1.0	10 / 1 / 0	<div><div></div></div> 45%		10 / 0 / 0	0%		8 / 0 / 0	0%		10 / 0 / 0	0%
AC25I	7198	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW28D	1756	MPZ	548.2	11 / 11 / 11	<div><div></div></div> 7%	157.0	11 / 11 / 11	<div><div></div></div> 2%	296.0	10 / 10 / 10	<div><div></div></div> 4%	10.5	11 / 6 / 0	<div><div></div></div> 0%
PMWD160	9	MPZ	1.2	10 / 1 / 0	<div><div></div></div> 47%		10 / 0 / 0	0%		8 / 0 / 0	0%		10 / 0 / 0	0%
MW18I	5273	MPZ	0.1	6 / 1 / 0	<div><div></div></div> 17%		6 / 0 / 0	0%		5 / 0 / 0	0%		6 / 0 / 0	0%
PMWC160	217	MPZ	1.1	10 / 1 / 0	<div><div></div></div> 3%		10 / 0 / 0	0%		8 / 0 / 0	0%		10 / 0 / 0	0%
AC03D	4459	MPZ	0.8	8 / 1 / 0	<div><div></div></div> 17%		8 / 0 / 0	0%		6 / 0 / 0	0%		8 / 0 / 0	0%
WILJDW00001	3057	MPZ	46.0	3 / 3 / 2	<div><div></div></div> 23%	23.1	3 / 3 / 1	<div><div></div></div> 11%	26.6	3 / 3 / 1	<div><div></div></div> 13%	9.6	3 / 1 / 0	<div><div></div></div> 5%
MW30D	4433	MPZ	23.9	14 / 12 / 3	<div><div></div></div> 8%	10.8	14 / 7 / 0	<div><div></div></div> 3%	16.2	13 / 9 / 3	<div><div></div></div> 5%		14 / 0 / 0	0%
WHMPZ	2953	MPZ	1.0	6 / 1 / 0	<div><div></div></div> 57%		6 / 0 / 0	0%		5 / 0 / 0	0%		6 / 0 / 0	0%
NWD4D	5457	MPZ	95.3	10 / 10 / 10	<div><div></div></div> 9%	65.2	10 / 10 / 10	<div><div></div></div> 6%	71.1	8 / 8 / 8	<div><div></div></div> 7%	9.7	10 / 7 / 0	<div><div></div></div> 1%
AC23D	4830	MPZ	52.8	12 / 12 / 12	<div><div></div></div> 6%	13.4	12 / 12 / 0	<div><div></div></div> 2%	25.8	10 / 10 / 3	<div><div></div></div> 3%		12 / 0 / 0	0%
MW07D	45	MPZ	1.0	7 / 1 / 0	<div><div></div></div> 3%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
MW12D	864	MPZ	1.0	7 / 1 / 0	<div><div></div></div> 3%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
MW24D	7067	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW27D	705	MPZ		14 / 0 / 0	0%		14 / 0 / 0	0%		12 / 0 / 0	0%		14 / 0 / 0	0%
MW25D	7776	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW31R	6364	MPZ	31.3	3 / 3 / 3	<div><div></div></div> 7%	8.5	3 / 3 / 0	<div><div></div></div> 2%	17.7	3 / 3 / 0	<div><div></div></div> 4%		3 / 0 / 0	0%
MW14D	2550	MPZ	74.1	16 / 16 / 16	<div><div></div></div> 7%	18.4	16 / 16 / 3	<div><div></div></div> 2%	41.1	14 / 14 / 6	<div><div></div></div> 4%		16 / 0 / 0	0%
MW26D	8562	MPZ	0.8	8 / 2 / 0	<div><div></div></div> 3%		8 / 0 / 0	0%		6 / 0 / 0	0%		8 / 0 / 0	0%
MW23I	7126	PC	79.4	12 / 11 / 11	<div><div></div></div> 7%	21.7	12 / 11 / 2	<div><div></div></div> 2%	34.6	10 / 9 / 7	<div><div></div></div> 3%		12 / 0 / 0	0%
MW16I	5877	PC	22.4	15 / 13 / 9	<div><div></div></div> 7%	17.8	15 / 13 / 2	<div><div></div></div> 6%	26.6	14 / 12 / 4	<div><div></div></div> 9%		15 / 0 / 0	0%
MW22D	2555	PC	56.7	11 / 5 / 3	<div><div></div></div> 7%	23.3	11 / 3 / 1	<div><div></div></div> 3%	33.5	9 / 4 / 2	<div><div></div></div> 4%		11 / 0 / 0	0%
MW21C	4128	PC	83.6	17 / 16 / 14	<div><div></div></div> 8%	30.1	17 / 15 / 7	<div><div></div></div> 3%	53.2	14 / 13 / 12	<div><div></div></div> 5%		17 / 0 / 0	0%
MW12C	864	PC	0.7	7 / 1 / 0	<div><div></div></div> 3%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
AC30D	6654	PC	0.1	7 / 1 / 0	<div><div></div></div> 31%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
AC28D	7798	PC	0.8	8 / 1 / 0	<div><div></div></div> 66%		8 / 0 / 0	0%		5 / 0 / 0	0%		8 / 0 / 0	0%
MW07C	55	PC	0.6	7 / 1 / 0	<div><div></div></div> 60%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
AC29D	5801	PC	2.3	10 / 2 / 0	<div><div></div></div> 15%	1.0	10 / 1 / 0	<div><div></div></div> 6%	2.0	8 / 1 / 0	<div><div></div></div> 13%		10 / 0 / 0	0%
AC27D	8686	PC	0.3	6 / 1 / 0	<div><div></div></div> 7%		6 / 0 / 0	0%		4 / 0 / 0	0%		6 / 0 / 0	0%
AC35D	7833	PC	17.4	12 / 12 / 11	<div><div></div></div> 6%	4.1	12 / 12 / 0	<div><div></div></div> 1%	8.9	11 / 11 / 0	<div><div></div></div> 3%	1.5	12 / 1 / 0	<div><div></div></div> 0%
AC24D	6030	PC	20.5	16 / 16 / 15	<div><div></div></div> 6%	5.5	16 / 15 / 0	<div><div></div></div> 2%	11.1	14 / 14 / 1	<div><div></div></div> 3%	29.0	16 / 1 / 0	<div><div></div></div> 8%
AC25D	7199	PC	32.1	12 / 11 / 10	<div><div></div></div> 6%	7.8	12 / 12 / 0	<div><div></div></div> 1%	16.1	11 / 10 / 0	<div><div></div></div> 3%		12 / 0 / 0	0%
MW15D	5274	PC	0.7	6 / 1 / 0	<div><div></div></div> 66%		6 / 0 / 0	0%		5 / 0 / 0	0%		6 / 0 / 0	0%
MW18D	5300	PC	0.1	7 / 1 / 0	<div><div></div></div> 4%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
MW16D	5885	PC	0.8	7 / 1 / 0	<div><div></div></div> 66%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%
MW23D	7068	PC	29.4	10 / 2 / 1	<div><div></div></div> 7%	12.0	10 / 1 / 0	<div><div></div></div> 3%	30.0	8 / 1 / 1	<div><div></div></div> 7%		10 / 0 / 0	0%
MW17D	6641	PC	0.9	7 / 1 / 0	<div><div></div></div> 63%		7 / 0 / 0	0%		5 / 0 / 0	0%		7 / 0 / 0	0%

Average Detections and Percent of All COC Detections

		COC Name	Phenanthrene			Fluorene			1,1-Biphenyl			Acenaphthene		
		COC CAS#	85-01-8			86-73-7			92-52-4			83-32-9		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
PMWA052	15	SZ	134.4	13 / 12 / 3	<div><div></div></div> 1%	224.5	13 / 12 / 3	<div><div></div></div> 2%	76.8	13 / 12 / 0	<div><div></div></div> 1%	400.8	13 / 13 / 7	<div><div></div></div> 3%
MW12S	854	SZ	0.2	6 / 1 / 0	<div><div></div></div> 3%	0.3	6 / 1 / 0	<div><div></div></div> 5%		6 / 0 / 0	0%	0.3	6 / 1 / 0	<div><div></div></div> 5%
PMWC049	224	SZ	19.7	12 / 10 / 0	<div><div></div></div> 2%	39.7	12 / 10 / 0	<div><div></div></div> 4%	17.6	12 / 10 / 0	<div><div></div></div> 2%	69.6	12 / 11 / 0	<div><div></div></div> 7%
MW01S	432	SZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
HW3PMWC55	605	SZ		18 / 0 / 0	0%	0.1	18 / 1 / 0	<div><div></div></div> 0%	1.5	17 / 1 / 0	<div><div></div></div> 2%	4.1	18 / 2 / 0	<div><div></div></div> 4%
HW2PMWC55	457	SZ	5.1	18 / 12 / 0	<div><div></div></div> 1%	8.0	18 / 15 / 0	<div><div></div></div> 2%	4.7	17 / 11 / 0	<div><div></div></div> 1%	15.5	18 / 16 / 0	<div><div></div></div> 4%
MW07S	23	SZ	0.2	8 / 1 / 0	<div><div></div></div> 1%	0.1	8 / 1 / 0	<div><div></div></div> 0%		8 / 0 / 0	0%	0.1	8 / 1 / 0	<div><div></div></div> 0%
MW32-60	1063	SZ	1.0	3 / 2 / 0	<div><div></div></div> 1%	2.3	3 / 3 / 0	<div><div></div></div> 3%	4.4	3 / 3 / 0	<div><div></div></div> 6%	2.9	3 / 3 / 0	<div><div></div></div> 4%
MW22I	2557	SZ	0.2	8 / 1 / 0	<div><div></div></div> 15%		8 / 0 / 0	0%		8 / 0 / 0	0%		8 / 0 / 0	0%
PMWD072	16	SZ	169.8	19 / 19 / 4	<div><div></div></div> 4%	159.7	19 / 19 / 0	<div><div></div></div> 4%	65.8	19 / 18 / 0	<div><div></div></div> 2%	264.4	19 / 19 / 1	<div><div></div></div> 6%
HW3PMWB71	602	SZ	45.9	19 / 14 / 0	<div><div></div></div> 1%	58.8	19 / 15 / 0	<div><div></div></div> 2%	28.2	18 / 14 / 0	<div><div></div></div> 1%	103.5	19 / 15 / 0	<div><div></div></div> 3%
HW2PMWB71	454	SZ	238.9	18 / 18 / 13	<div><div></div></div> 3%	223.3	18 / 18 / 2	<div><div></div></div> 3%	81.5	17 / 17 / 0	<div><div></div></div> 1%	340.0	18 / 18 / 1	<div><div></div></div> 4%
MW14S	2533	LPZ	0.2	8 / 1 / 0	<div><div></div></div> 3%		8 / 0 / 0	0%		8 / 0 / 0	0%		8 / 0 / 0	0%
WILJDW00002	3060	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%
MW21S	4121	LPZ	0.2	6 / 1 / 0	<div><div></div></div> 12%		6 / 0 / 0	0%		6 / 0 / 0	0%		6 / 0 / 0	0%
AC24S	6023	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
HW3PMWA91	594	LPZ	19.3	19 / 17 / 0	<div><div></div></div> 1%	42.2	19 / 16 / 0	<div><div></div></div> 3%	17.9	18 / 15 / 0	<div><div></div></div> 1%	64.0	19 / 16 / 0	<div><div></div></div> 4%
HW2PMWA91	446	LPZ	130.5	21 / 20 / 2	<div><div></div></div> 2%	186.2	21 / 20 / 3	<div><div></div></div> 2%	77.9	19 / 18 / 0	<div><div></div></div> 1%	312.1	21 / 21 / 6	<div><div></div></div> 4%
MW36	6648	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%
MW34-99	2073	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%
MW32-99	1066	LPZ	8.4	4 / 4 / 0	<div><div></div></div> 6%	5.9	4 / 3 / 0	<div><div></div></div> 4%	2.1	4 / 3 / 0	<div><div></div></div> 2%	16.3	4 / 4 / 0	<div><div></div></div> 12%
MWSB3	12	LPZ	0.3	6 / 1 / 0	<div><div></div></div> 5%	0.1	6 / 1 / 0	<div><div></div></div> 2%		6 / 0 / 0	0%		6 / 0 / 0	0%
MW25S	7789	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW26S	8566	LPZ	0.2	4 / 1 / 0	<div><div></div></div> 2%		4 / 0 / 0	0%		4 / 0 / 0	0%		4 / 0 / 0	0%
AC27S	8692	LPZ	0.2	3 / 1 / 0	<div><div></div></div> 6%	0.1	3 / 1 / 0	<div><div></div></div> 3%		3 / 0 / 0	0%	0.1	3 / 1 / 0	<div><div></div></div> 3%
NWD4S	5463	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW14I	2557	LPZ	1.6	13 / 4 / 0	<div><div></div></div> 0%	1.6	13 / 4 / 0	<div><div></div></div> 0%	13.0	13 / 2 / 0	<div><div></div></div> 1%	8.7	13 / 3 / 0	<div><div></div></div> 1%
PMWC102	233	LPZ	0.3	11 / 1 / 0	<div><div></div></div> 1%	0.1	11 / 1 / 0	<div><div></div></div> 0%		11 / 0 / 0	0%	0.2	11 / 1 / 0	<div><div></div></div> 1%
PMWA110	2	LPZ	72.5	13 / 13 / 0	<div><div></div></div> 1%	147.3	13 / 13 / 0	<div><div></div></div> 1%	101.5	13 / 13 / 0	<div><div></div></div> 1%	356.9	13 / 13 / 2	<div><div></div></div> 3%
MW21I	2549	LPZ	0.9	8 / 1 / 0	<div><div></div></div> 0%	0.7	8 / 1 / 0	<div><div></div></div> 0%	4.4	8 / 1 / 0	<div><div></div></div> 2%		8 / 0 / 0	0%
MW24S	7070	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW09I	417	LPZ	0.2	8 / 1 / 0	<div><div></div></div> 4%		8 / 0 / 0	0%		8 / 0 / 0	0%		8 / 0 / 0	0%
MW35-94	5815	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%
MW12I	846	LPZ	61.5	13 / 13 / 0	<div><div></div></div> 4%	88.6	13 / 13 / 0	<div><div></div></div> 6%	24.5	13 / 13 / 0	<div><div></div></div> 2%	98.5	13 / 13 / 0	<div><div></div></div> 7%
MW07I	34	LPZ	79.5	20 / 20 / 0	<div><div></div></div> 0%	228.5	20 / 20 / 2	<div><div></div></div> 1%	119.4	20 / 20 / 0	<div><div></div></div> 1%	457.5	20 / 20 / 14	<div><div></div></div> 3%
MW15S	5264	LPZ	0.1	5 / 1 / 0	<div><div></div></div> 2%	0.3	5 / 1 / 0	<div><div></div></div> 4%		5 / 0 / 0	0%	0.4	5 / 1 / 0	<div><div></div></div> 5%
MW33-117	1666	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%



Average Detections and Percent of All COC Detections

		COC Name	Phenanthrene			Fluorene			1,1-Biphenyl			Acenaphthene		
		COC CAS#	85-01-8			86-73-7			92-52-4			83-32-9		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
MW29D	1839	MPZ	36.4	9 / 9 / 0	<div><div></div></div> 1%	79.3	9 / 9 / 0	<div><div></div></div> 2%	44.4	9 / 9 / 0	<div><div></div></div> 1%	144.7	9 / 9 / 0	<div><div></div></div> 4%
AC02D	2856	MPZ	5.7	13 / 6 / 0	<div><div></div></div> 1%	7.0	13 / 6 / 0	<div><div></div></div> 1%	5.5	13 / 7 / 0	<div><div></div></div> 1%	11.6	13 / 9 / 0	<div><div></div></div> 2%
MW35-129	5815	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%		3 / 0 / 0	0%
MW34-147	2065	MPZ	22.7	3 / 3 / 0	<div><div></div></div> 1%	29.0	3 / 3 / 0	<div><div></div></div> 1%	18.3	3 / 3 / 0	<div><div></div></div> 1%	55.7	3 / 3 / 0	<div><div></div></div> 3%
MW32-147	1068	MPZ	45.7	3 / 3 / 0	<div><div></div></div> 0%	173.3	3 / 3 / 0	<div><div></div></div> 1%	112.3	3 / 3 / 0	<div><div></div></div> 1%	343.3	3 / 3 / 0	<div><div></div></div> 3%
MW21D	4136	MPZ	2.2	22 / 18 / 0	<div><div></div></div> 1%	4.1	22 / 18 / 0	<div><div></div></div> 1%	3.2	22 / 18 / 0	<div><div></div></div> 1%	7.7	22 / 17 / 0	<div><div></div></div> 2%
MW33-156	1669	MPZ	5.0	3 / 3 / 0	<div><div></div></div> 2%	5.7	3 / 3 / 0	<div><div></div></div> 2%	2.5	3 / 3 / 0	<div><div></div></div> 1%	10.0	3 / 3 / 0	<div><div></div></div> 4%
PMWB160	8	MPZ	4.3	16 / 6 / 0	<div><div></div></div> 2%	5.3	16 / 7 / 0	<div><div></div></div> 3%	3.1	16 / 7 / 0	<div><div></div></div> 2%	10.1	16 / 7 / 0	<div><div></div></div> 5%
MW15I	5287	MPZ	0.2	6 / 1 / 0	<div><div></div></div> 5%		6 / 0 / 0	0%		6 / 0 / 0	0%		6 / 0 / 0	0%
PMWA160	1	MPZ	0.2	10 / 1 / 0	<div><div></div></div> 11%	0.1	10 / 1 / 0	<div><div></div></div> 6%		10 / 0 / 0	0%		10 / 0 / 0	0%
AC25I	7198	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW28D	1756	MPZ	14.6	11 / 11 / 0	<div><div></div></div> 0%	92.4	11 / 11 / 0	<div><div></div></div> 1%	70.2	11 / 11 / 0	<div><div></div></div> 1%	213.6	11 / 11 / 0	<div><div></div></div> 3%
PMWD160	9	MPZ	0.3	10 / 1 / 0	<div><div></div></div> 12%	0.1	10 / 1 / 0	<div><div></div></div> 4%		10 / 0 / 0	0%		10 / 0 / 0	0%
MW18I	5273	MPZ		6 / 0 / 0	0%		6 / 0 / 0	0%		6 / 0 / 0	0%		6 / 0 / 0	0%
PMWC160	217	MPZ	0.2	10 / 1 / 0	<div><div></div></div> 1%	0.1	10 / 1 / 0	<div><div></div></div> 0%		10 / 0 / 0	0%	0.1	10 / 1 / 0	<div><div></div></div> 0%
AC03D	4459	MPZ	0.2	8 / 1 / 0	<div><div></div></div> 4%	0.1	8 / 1 / 0	<div><div></div></div> 2%		8 / 0 / 0	0%		8 / 0 / 0	0%
WILJDW00001	3057	MPZ	7.3	3 / 3 / 0	<div><div></div></div> 4%	9.8	3 / 3 / 0	<div><div></div></div> 5%	9.8	3 / 3 / 0	<div><div></div></div> 5%	22.9	3 / 3 / 0	<div><div></div></div> 11%
MW30D	4433	MPZ	5.2	14 / 5 / 0	<div><div></div></div> 2%	6.0	14 / 6 / 0	<div><div></div></div> 2%	3.2	14 / 7 / 0	<div><div></div></div> 1%	10.2	14 / 8 / 0	<div><div></div></div> 3%
WHMPZ	2953	MPZ	0.2	6 / 1 / 0	<div><div></div></div> 13%	0.1	6 / 1 / 0	<div><div></div></div> 6%		6 / 0 / 0	0%		6 / 0 / 0	0%
NWD4D	5457	MPZ	10.2	10 / 10 / 0	<div><div></div></div> 1%	32.6	10 / 10 / 0	<div><div></div></div> 3%	30.5	10 / 10 / 0	<div><div></div></div> 3%	81.5	10 / 10 / 0	<div><div></div></div> 8%
AC23D	4830	MPZ	4.9	12 / 12 / 0	<div><div></div></div> 1%	3.9	12 / 12 / 0	<div><div></div></div> 0%	5.5	12 / 12 / 0	<div><div></div></div> 1%	12.1	12 / 11 / 0	<div><div></div></div> 1%
MW07D	45	MPZ	0.2	7 / 1 / 0	<div><div></div></div> 1%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
MW12D	864	MPZ	0.2	7 / 1 / 0	<div><div></div></div> 1%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
MW24D	7067	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW27D	705	MPZ		14 / 0 / 0	0%		14 / 0 / 0	0%		14 / 0 / 0	0%		14 / 0 / 0	0%
MW25D	7776	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%		2 / 0 / 0	0%
MW31R	6364	MPZ	1.9	3 / 3 / 0	<div><div></div></div> 0%	1.5	3 / 3 / 0	<div><div></div></div> 0%	3.9	3 / 3 / 0	<div><div></div></div> 1%	4.2	3 / 3 / 0	<div><div></div></div> 1%
MW14D	2550	MPZ	1.9	16 / 14 / 0	<div><div></div></div> 0%	1.9	16 / 14 / 0	<div><div></div></div> 0%	9.0	16 / 16 / 0	<div><div></div></div> 1%	7.5	16 / 14 / 0	<div><div></div></div> 1%
MW26D	8562	MPZ	0.2	8 / 2 / 0	<div><div></div></div> 1%	0.1	8 / 2 / 0	<div><div></div></div> 0%		8 / 0 / 0	0%		8 / 0 / 0	0%
MW23I	7126	PC	10.5	12 / 12 / 0	<div><div></div></div> 1%	4.1	12 / 12 / 0	<div><div></div></div> 0%	5.5	12 / 12 / 0	<div><div></div></div> 0%	12.1	12 / 11 / 0	<div><div></div></div> 1%
MW16I	5877	PC	2.6	15 / 11 / 0	<div><div></div></div> 1%	7.9	15 / 13 / 0	<div><div></div></div> 3%	7.5	15 / 14 / 0	<div><div></div></div> 2%	21.0	15 / 13 / 0	<div><div></div></div> 7%
MW22D	2555	PC	8.2	11 / 4 / 0	<div><div></div></div> 1%	4.9	11 / 4 / 0	<div><div></div></div> 1%	11.3	11 / 3 / 0	<div><div></div></div> 1%	14.5	11 / 3 / 0	<div><div></div></div> 2%
MW21C	4128	PC	5.4	17 / 16 / 0	<div><div></div></div> 1%	7.1	17 / 17 / 0	<div><div></div></div> 1%	12.6	17 / 17 / 0	<div><div></div></div> 1%	19.9	17 / 15 / 0	<div><div></div></div> 2%
MW12C	864	PC	0.2	7 / 1 / 0	<div><div></div></div> 1%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
AC30D	6654	PC		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
AC28D	7798	PC	0.2	8 / 1 / 0	<div><div></div></div> 16%		8 / 0 / 0	0%		8 / 0 / 0	0%		8 / 0 / 0	0%
MW07C	55	PC	0.2	7 / 1 / 0	<div><div></div></div> 16%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
AC29D	5801	PC	0.3	10 / 1 / 0	<div><div></div></div> 2%	0.3	10 / 2 / 0	<div><div></div></div> 2%	0.2	10 / 1 / 0	<div><div></div></div> 1%		10 / 0 / 0	0%
AC27D	8686	PC		6 / 0 / 0	0%		6 / 0 / 0	0%		6 / 0 / 0	0%	0.1	6 / 1 / 0	<div><div></div></div> 2%
AC35D	7833	PC	1.6	12 / 12 / 0	<div><div></div></div> 1%	0.5	12 / 3 / 0	<div><div></div></div> 0%	2.1	12 / 12 / 0	<div><div></div></div> 1%	0.3	12 / 1 / 0	<div><div></div></div> 0%
AC24D	6030	PC	2.4	16 / 16 / 0	<div><div></div></div> 1%	2.0	16 / 13 / 0	<div><div></div></div> 1%	2.7	16 / 15 / 0	<div><div></div></div> 1%	4.7	16 / 16 / 0	<div><div></div></div> 1%
AC25D	7199	PC	3.7	12 / 12 / 0	<div><div></div></div> 1%	1.5	12 / 12 / 0	<div><div></div></div> 0%	3.9	12 / 11 / 0	<div><div></div></div> 1%	2.8	12 / 11 / 0	<div><div></div></div> 1%
MW15D	5274	PC	0.2	6 / 1 / 0	<div><div></div></div> 15%		6 / 0 / 0	0%		6 / 0 / 0	0%		6 / 0 / 0	0%
MW18D	5300	PC		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
MW16D	5885	PC	0.2	7 / 1 / 0	<div><div></div></div> 16%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%
MW23D	7068	PC	1.2	10 / 2 / 0	<div><div></div></div> 0%	1.1	10 / 2 / 0	<div><div></div></div> 0%	6.2	10 / 1 / 0	<div><div></div></div> 1%	2.6	10 / 2 / 0	<div><div></div></div> 1%
MW17D	6641	PC	0.2	7 / 1 / 0	<div><div></div></div> 15%		7 / 0 / 0	0%		7 / 0 / 0	0%		7 / 0 / 0	0%

Average Detections and Percent of All COC Detections

		COC Name	Phenol			Benzo(a)pyrene			Benzene		
		COC CAS#	108-95-2			50-32-8			71-43-2		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
PMWA052	15	SZ	11.1	13 / 7 / 0	0%		13 / 0 / 0	0%		0 / 0 / 0	0%
MW12S	854	SZ	2.4	6 / 1 / 0	41%		6 / 0 / 0	0%		0 / 0 / 0	0%
PMWC049	224	SZ	30.0	12 / 1 / 0	3%		12 / 0 / 0	0%		0 / 0 / 0	0%
MW01S	432	SZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
HW3PMWC55	605	SZ		17 / 0 / 0	0%		18 / 0 / 0	0%		0 / 0 / 0	0%
HW2PMWC55	457	SZ		17 / 0 / 0	0%		18 / 0 / 0	0%		0 / 0 / 0	0%
MW07S	23	SZ	29.0	8 / 1 / 0	84%		8 / 0 / 0	0%		0 / 0 / 0	0%
MW32-60	1063	SZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW22I	2557	SZ		8 / 0 / 0	0%		8 / 0 / 0	0%		0 / 0 / 0	0%
PMWD072	16	SZ	4.9	19 / 1 / 0	0%		19 / 0 / 0	0%		0 / 0 / 0	0%
HW3PMWB71	602	SZ	2.2	18 / 1 / 0	0%		19 / 0 / 0	0%		0 / 0 / 0	0%
HW2PMWB71	454	SZ	18.0	17 / 5 / 0	0%		18 / 0 / 0	0%		0 / 0 / 0	0%
MW14S	2533	LPZ		8 / 0 / 0	0%		8 / 0 / 0	0%		0 / 0 / 0	0%
WILJDW00002	3060	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW21S	4121	LPZ		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
AC24S	6023	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
HW3PMWA91	594	LPZ	2.2	18 / 1 / 0	0%		19 / 0 / 0	0%		0 / 0 / 0	0%
HW2PMWA91	446	LPZ	6.6	19 / 5 / 0	0%		21 / 0 / 0	0%		0 / 0 / 0	0%
MW36	6648	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW34-99	2073	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW32-99	1066	LPZ		4 / 0 / 0	0%		4 / 0 / 0	0%		0 / 0 / 0	0%
MWSB3	12	LPZ		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
MW25S	7789	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
MW26S	8566	LPZ		4 / 0 / 0	0%		4 / 0 / 0	0%		0 / 0 / 0	0%
AC27S	8692	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
NWD4S	5463	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
MW14I	2557	LPZ		13 / 0 / 0	0%		13 / 0 / 0	0%		0 / 0 / 0	0%
PMWC102	233	LPZ	29.0	11 / 1 / 0	87%		11 / 0 / 0	0%		0 / 0 / 0	0%
PMWA110	2	LPZ	3.9	13 / 1 / 0	0%		13 / 0 / 0	0%		0 / 0 / 0	0%
MW21I	2549	LPZ		8 / 0 / 0	0%		8 / 0 / 0	0%		0 / 0 / 0	0%
MW24S	7070	LPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
MW09I	417	LPZ		8 / 0 / 0	0%		8 / 0 / 0	0%		0 / 0 / 0	0%
MW35-94	5815	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW12I	846	LPZ	1.9	13 / 1 / 0	0%		13 / 0 / 0	0%		0 / 0 / 0	0%
MW07I	34	LPZ	12.8	20 / 4 / 0	0%		20 / 0 / 0	0%		1 / 0 / 0	0%
MW15S	5264	LPZ		5 / 0 / 0	0%		5 / 0 / 0	0%		0 / 0 / 0	0%
MW33-117	1666	LPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%

Average Detections and Percent of All COC Detections

		COC Name	Phenol			Benzo(a)pyrene			Benzene		
		COC CAS#	108-95-2			50-32-8			71-43-2		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
MW29D	1839	MPZ		9 / 0 / 0	0%		9 / 0 / 0	0%	1.1	2 / 2 / 1	<div>0%</div>
AC02D	2856	MPZ		13 / 0 / 0	0%		13 / 0 / 0	0%		0 / 0 / 0	0%
MW35-129	5815	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW34-147	2065	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW32-147	1068	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW21D	4136	MPZ		22 / 0 / 0	0%		22 / 0 / 0	0%		0 / 0 / 0	0%
MW33-156	1669	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
PMWB160	8	MPZ		16 / 0 / 0	0%		16 / 0 / 0	0%		0 / 0 / 0	0%
MW15I	5287	MPZ		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
PMWA160	1	MPZ		10 / 0 / 0	0%		10 / 0 / 0	0%		0 / 0 / 0	0%
AC25I	7198	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
MW28D	1756	MPZ		11 / 0 / 0	0%		11 / 0 / 0	0%	2.0	1 / 1 / 1	<div>0%</div>
PMWD160	9	MPZ		10 / 0 / 0	0%		10 / 0 / 0	0%		0 / 0 / 0	0%
MW18I	5273	MPZ		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
PMWC160	217	MPZ	27.0	10 / 1 / 0	<div>85%</div>		10 / 0 / 0	0%		0 / 0 / 0	0%
AC03D	4459	MPZ		8 / 0 / 0	0%	0.6	8 / 1 / 1	<div>12%</div>		0 / 0 / 0	0%
WILJDW00001	3057	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW30D	4433	MPZ		14 / 0 / 0	0%		14 / 0 / 0	0%		0 / 0 / 0	0%
WHMPZ	2953	MPZ		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
NWD4D	5457	MPZ		10 / 0 / 0	0%		10 / 0 / 0	0%		0 / 0 / 0	0%
AC23D	4830	MPZ		12 / 0 / 0	0%		12 / 0 / 0	0%		0 / 0 / 0	0%
MW07D	45	MPZ	27.0	7 / 1 / 0	<div>88%</div>		7 / 0 / 0	0%		0 / 0 / 0	0%
MW12D	864	MPZ	33.0	7 / 1 / 0	<div>90%</div>		7 / 0 / 0	0%		0 / 0 / 0	0%
MW24D	7067	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
MW27D	705	MPZ		14 / 0 / 0	0%		14 / 0 / 0	0%		0 / 0 / 0	0%
MW25D	7776	MPZ		2 / 0 / 0	0%		2 / 0 / 0	0%		0 / 0 / 0	0%
MW31R	6364	MPZ		3 / 0 / 0	0%		3 / 0 / 0	0%		0 / 0 / 0	0%
MW14D	2550	MPZ		16 / 0 / 0	0%		16 / 0 / 0	0%		0 / 0 / 0	0%
MW26D	8562	MPZ	30.0	8 / 1 / 0	<div>94%</div>		8 / 0 / 0	0%		0 / 0 / 0	0%
MW23I	7126	PC		12 / 0 / 0	0%		12 / 0 / 0	0%		0 / 0 / 0	0%
MW16I	5877	PC	2.0	15 / 1 / 0	<div>1%</div>		15 / 0 / 0	0%		0 / 0 / 0	0%
MW22D	2555	PC		11 / 0 / 0	0%		11 / 0 / 0	0%		0 / 0 / 0	0%
MW21C	4128	PC		17 / 0 / 0	0%		17 / 0 / 0	0%		0 / 0 / 0	0%
MW12C	864	PC	23.0	7 / 1 / 0	<div>90%</div>	0.6	7 / 2 / 1	<div>2%</div>		0 / 0 / 0	0%
AC30D	6654	PC		7 / 0 / 0	0%		7 / 0 / 0	0%		0 / 0 / 0	0%
AC28D	7798	PC		8 / 0 / 0	0%		8 / 0 / 0	0%		0 / 0 / 0	0%
MW07C	55	PC		7 / 0 / 0	0%		7 / 0 / 0	0%		0 / 0 / 0	0%
AC29D	5801	PC		10 / 0 / 0	0%		10 / 0 / 0	0%		0 / 0 / 0	0%
AC27D	8686	PC		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
AC35D	7833	PC		12 / 0 / 0	0%		12 / 0 / 0	0%		0 / 0 / 0	0%
AC24D	6030	PC		16 / 0 / 0	0%		16 / 0 / 0	0%		0 / 0 / 0	0%
AC25D	7199	PC		12 / 0 / 0	0%		12 / 0 / 0	0%		0 / 0 / 0	0%
MW15D	5274	PC		6 / 0 / 0	0%		6 / 0 / 0	0%		0 / 0 / 0	0%
MW18D	5300	PC	2.4	7 / 1 / 0	<div>78%</div>		7 / 0 / 0	0%		0 / 0 / 0	0%
MW16D	5885	PC		7 / 0 / 0	0%		7 / 0 / 0	0%		0 / 0 / 0	0%
MW23D	7068	PC		10 / 0 / 0	0%		10 / 0 / 0	0%		0 / 0 / 0	0%
MW17D	6641	PC		7 / 0 / 0	0%		7 / 0 / 0	0%		0 / 0 / 0	0%



Average Detections and Percent of All COC Detections

		COC Name	Nitrobenzene			1,2,4-Trimethylbenzene			1,3,5-Trimethylbenzene		
		COC CAS#	98-95-3			95-63-6			108-67-8		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
PMWA052	15	SZ		13 / 0 / 0	0%	20.0	1 / 1 / 0	<div><div></div></div> 0%		0 / 0 / 0	0%
MW12S	854	SZ		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWC049	224	SZ		12 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW01S	432	SZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
HW3PMWC55	605	SZ		17 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
HW2PMWC55	457	SZ		17 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW07S	23	SZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW32-60	1063	SZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW22I	2557	SZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWD072	16	SZ		19 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
HW3PMWB71	602	SZ		18 / 0 / 0	0%	10.0	1 / 1 / 0	<div><div></div></div> 0%		0 / 0 / 0	0%
HW2PMWB71	454	SZ		17 / 0 / 0	0%		0 / 0 / 0	0%	10.0	1 / 1 / 0	<div><div></div></div> 0%
MW14S	2533	LPZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
WILJDW00002	3060	LPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW21S	4121	LPZ		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC24S	6023	LPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
HW3PMWA91	594	LPZ		18 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
HW2PMWA91	446	LPZ		19 / 0 / 0	0%	10.0	1 / 1 / 0	<div><div></div></div> 0%		0 / 0 / 0	0%
MW36	6648	LPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW34-99	2073	LPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW32-99	1066	LPZ		4 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MWSB3	12	LPZ		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW25S	7789	LPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW26S	8566	LPZ		4 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC27S	8692	LPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
NWD4S	5463	LPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW14I	2557	LPZ		13 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWC102	233	LPZ		11 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWA110	2	LPZ		13 / 0 / 0	0%	60.0	1 / 1 / 0	<div><div></div></div> 0%	20.0	1 / 1 / 0	<div><div></div></div> 0%
MW21I	2549	LPZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW24S	7070	LPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW09I	417	LPZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW35-94	5815	LPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW12I	846	LPZ		13 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW07I	34	LPZ		20 / 0 / 0	0%	38.8	4 / 4 / 0	<div><div></div></div> 0%	19.3	4 / 4 / 0	<div><div></div></div> 0%
MW15S	5264	LPZ		5 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW33-117	1666	LPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%

Average Detections and Percent of All COC Detections

		COC Name	Nitrobenzene			1,2,4-Trimethylbenzene			1,3,5-Trimethylbenzene		
		COC CAS#	98-95-3			95-63-6			108-67-8		
Monitoring Location	Distance from SWMU10 (ft)	Zone	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs	Average Detection (ug/L)	# Sampled / #Detected / #>CG	Percent of All COCs
MW29D	1839	MPZ		9 / 0 / 0	0%	18.0	2 / 2 / 0	<div>0%</div>	7.7	2 / 2 / 0	<div>0%</div>
AC02D	2856	MPZ		13 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW35-129	5815	MPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW34-147	2065	MPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW32-147	1068	MPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW21D	4136	MPZ		22 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW33-156	1669	MPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWB160	8	MPZ		16 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW15I	5287	MPZ		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWA160	1	MPZ		10 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC25I	7198	MPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW28D	1756	MPZ		11 / 0 / 0	0%	28.0	1 / 1 / 0	<div>0%</div>	9.0	2 / 2 / 0	<div>0%</div>
PMWD160	9	MPZ		10 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW18I	5273	MPZ		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
PMWC160	217	MPZ		10 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC03D	4459	MPZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
WILJDW00001	3057	MPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW30D	4433	MPZ		14 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
WHMPZ	2953	MPZ		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
NWD4D	5457	MPZ		10 / 0 / 0	0%	4.0	1 / 1 / 0	<div>0%</div>	6.0	1 / 1 / 0	<div>1%</div>
AC23D	4830	MPZ		12 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW07D	45	MPZ		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW12D	864	MPZ		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW24D	7067	MPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW27D	705	MPZ		14 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW25D	7776	MPZ		2 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW31R	6364	MPZ		3 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW14D	2550	MPZ		16 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW26D	8562	MPZ		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW23I	7126	PC		12 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW16I	5877	PC		15 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW22D	2555	PC		11 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW21C	4128	PC		17 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW12C	864	PC		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC30D	6654	PC		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC28D	7798	PC		8 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW07C	55	PC		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC29D	5801	PC		10 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC27D	8686	PC		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC35D	7833	PC		12 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC24D	6030	PC		16 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
AC25D	7199	PC		12 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW15D	5274	PC		6 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW18D	5300	PC		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW16D	5885	PC		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW23D	7068	PC		10 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%
MW17D	6641	PC		7 / 0 / 0	0%		0 / 0 / 0	0%		0 / 0 / 0	0%

## APPENDIX I – DATA REVIEW

Figure I-1: Groundwater Monitoring Results from the May 2017 Annual OU1 O&M Report

TABLE 2: GROUNDWATER MONITORING WELL DETECTION ANALYTICAL SUMMARY - PAHs

Facility ID#: FLD008168346

Facility Name: Escambia Treating Company Superfund Site

Sample		1-Methyl-naphthalene	2,3,4,6-Tetrachlorophenol	2-Methyl-naphthalene	Acenaphthene	Acenaphthylene	Anthracene	Carbazole	Dibenzofuran	Fluorene	Indeno [1,2,3-cd] pyrene	Naphthalene	Pentachlorophenol	Phenanthrene
Location	Date	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
CC-PMW-001	4/30/2013	NS	NS	5.1 U	5.1 U	5.1 U	5.1 U	5.1 U	5.1 U	5.1 U	NS	5.1 U	25 U	5.1 U
CC-PMW-002	4/30/2013	NS	NS	8.1	11	5.1 U	5.1 U	3.8 J	7.6	6.6	NS	28	25 U	2.8 J
CC-PMW-001	11/7/2014	0.50 U	0.64 U	0.54 U	0.46 U	0.56 U	0.42 U	0.87 U	0.52 U	0.56 U	1.0 U	0.63 U	1.8 U	0.41 U
CC-PMW-002	11/7/2014	110	30 I	200	140	3.2 I	2.6 I	100	100	92	84	1300	160	58
CC-PMW-001	6/25/2015	NS	NS	0.54 U	0.46 U	0.56 U	0.42 U	0.87 U	0.52 U	0.56 U	NS	0.63 U	1.8 U	0.41 U
CC-PMW-002	6/25/2015	NS	NS	1.2 I	0.46 U	0.56 U	0.42 U	2.3 I	0.96 I	1.2 I	NS	1.3 I	5.9 I	0.41 U
CC-PMW-001	11/12/2015	NS	NS	0.54 U	0.46 U	0.56 U	0.42 U	0.87 U	0.52 U	0.56 U	1.0 U	0.63 U	1.8 U	0.41 U
CC-PMW-002	11/12/2015	NS	NS	0.54 U	0.46 U	0.56 U	0.42 U	0.87 U	0.52 U	0.56 U	1.0 U	0.63 U	1.8 U	0.41 U
MW37S	11/3/2015	2.1 U	10 U	2.1 U	2.1 U	2.1 U	2.1 U	1.9 U	2.1 U	2.1 U	NS	2.1 U	1.0 U	2.1 U
CC-PMW-001	11/5/2016	NS	NS	2.2 U	1.8 U	2.2 U	1.7 U	3.5 U	2.1 U	2.2 U	4.1 UJ	2.5 U	7.2 U	1.6 U
CC-PMW-002	11/5/2016	NS	NS	2.2 U	1.8 U	2.2 U	1.7 U	3.5 U	2.1 U	2.2 U	4.1 U	2.5 U	7.2 U	1.6 U
MW37S	11/5/2016	NS	NS	2.2 U	1.8 U	2.2 U	1.7 U	3.5 U	2.1 U	2.2 U	4.1 UJ	2.5 U	7.2 U	1.6 U
GCTLs		28	NA	28	20	210	2100	1.8	28	280	NA	14	1	210
NADCs		280	NA	280	200	2100	21000	180	280	2800	NA	140	1	2100

**Notes:**

ug/L = micrograms per liter

GCTLs = Groundwater Cleanup Target Levels specified in F.A.C. Table I of Chapter 62-777, F.A.C.

NADCs = Natural Attenuation Default Source Concentrations specified in F.A.C. Table I of Chapter 62-777, F.A.C.

NS = Not Sampled

**Bold** = Exceeds GCTL Limit

NA = Not Available

**Qualifier**

**Qualifier Description**

U

Indicates that the compound was analyzed for but not detected.

I

The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

J

Estimated value < PQL and ≥ MDL



Excerpt from 2017 OU1 Five Year Review

Figure I-2: Groundwater Elevation Monitoring Results from the May 2017 Annual OU1 O&M Report

Monitoring Well	Date	Ground Elevation or TOC (flush mount)	Well Riser Height	Depth to Water	Water Table Elevation	Bottom of Soil Cell Elevation	Distance from bottom of soil cell to water table
CC-PMW-001	2/20/14	89.9	3.2	46.38	46.7	55.0	8.3
CC-PMW-002	2/20/14	84.7	2.8	42.28	45.2	55.0	9.8
CC-PMW-001	5/5/14	89.9	3.2	40.88	52.2	55.0	2.8
CC-PMW-002	5/5/14	84.7	2.8	27.55	59.9	55.0	-4.9
CC-PMW-001	6/6/14	89.9	3.2	36.92	56.1	55.0	-1.1
CC-PMW-002	6/6/14	84.7	2.8	32.75	54.7	55.0	0.3
CC-PMW-001	8/22/14	89.9	3.2	38.27	54.8	55.0	0.2
CC-PMW-002	8/22/14	84.7	2.8	34.3	53.2	55.0	1.8
CC-PMW-001	11/7/14	89.9	3.2	40.22	52.8	55.0	2.2
CC-PMW-002	11/7/14	84.7	2.8	36.3	51.2	55.0	3.8
CC-PMW-001	2/12/15	89.9	3.2	42.72	50.3	55.0	4.7
CC-PMW-002	2/12/15	84.7	2.8	38.55	48.9	55.0	6.1
CC-PMW-001	5/1/15	89.9	3.2	43.35	49.7	55.0	5.3
CC-PMW-002	5/1/15	84.7	2.8	38.62	48.8	55.0	6.2
CC-PMW-001	8/20/15	89.9	3.2	44.70	48.4	55.0	6.6
CC-PMW-002	8/20/15	84.7	2.8	40.42	47.0	55.0	8.0
CC-PMW-001	11/12/15	89.9	3.2	44.84	48.2	55.0	6.8
CC-PMW-002	11/12/15	84.7	2.8	39.56	47.9	55.0	7.1
CC-PMW-001	5/2/16	89.9	3.2	42.86	50.2	55.0	4.8
CC-PMW-002	5/2/16	84.7	2.8	38.63	48.8	55.0	6.2
CC-PMW-001	11/5/16	89.9	3.2	43.76	49.3	55.0	5.7
CC-PMW-002	11/5/16	84.7	2.8	39.77	47.7	55.0	7.3
MW37	11/5/16	85.69	NA	37.74	47.95	55.0	7.1
CC-PMW-001	5/9/2017	89.9	3.2	44.61	48.5	55.0	6.6
CC-PMW-002	5/9/2017	84.7	2.8	40.72	46.7	55.0	8.3
MW-37	5/9/2017	85.69	85.69	38.68	47.01	55.0	8.0

<5 feet separation between bottom of OU-1 soil cell and water table
 >5 feet separation between bottom of OU-1 soil cell and water table

**ATTACHMENT C**  
**Literature Review of PAH and PCP Degradation**

*Title: Literature Review of PAH and PCP Degradation applied to McCormick and Baxter Superfund Site*

*Author: Dr. Carol Dona, U.S. Army Corps of Engineers Environmental and Munitions Center of Expertise*

## 1.0 Introduction

A literature review was performed for PAH and PCP degradation with the following purposes: 1) determination of the conditions under which the different PAHs and PCP were expected to degrade, and 2) estimation of the ranges of rate constants expected for the conditions under which PAH and/or PCP degradation might occur, and 3) application of the literature information to the PCP degradation expected from the conditions in the groundwater at the site. The results are included below.

### 1.1 PCP

#### 1.1.1 Introduction

Field data from the McCormick and Baxter site indicate that anaerobic conditions exist throughout the groundwater where PCP is present, as well as the groundwater immediately upgradient, sidegradient, and downgradient of the PCP contamination (USACE 2010). Degradation of PCP is generally thought to proceed under anaerobic conditions through reductive dechlorination (D'Angelo and Redding, 2000). This is a process where microorganisms potentially use hydrogen ( $H_2$ ) in the groundwater as an electron donor and the chlorine atoms on the PCP as electron acceptors, replacing the chlorine atoms with hydrogen atoms via reductive dechlorination. For PCP reductive dechlorination to occur, sufficient amounts of  $H_2$  and the appropriate strains of microorganisms to degrade the PCP need to be present, and other electron acceptors need to be present at low enough concentrations so they do not compete significantly with the chlorines on the PCP for the electron acceptor role.

One of the potential difficulties in relating the results of literature studies to the PCP degradation expected in groundwater at the site is establishing relationships between the parameters used in the studies and the parameters of the groundwater at the site as known from collection of field characterization data.



Geochemical parameters are relatively easy to relate between the studies and the site groundwater. The electron acceptors other than the chlorines on PCP that are present in the McCormick and Baxter groundwater include nitrate, ferric iron, sulfate, and carbon dioxide, with the geochemical conditions where these electron acceptors are active being defined as nitrate-reducing, iron-reducing, sulfate-reducing, and methanogenic, respectively. The studies summarized below largely use the same geochemical parameters in the field groundwater characterization to describe the electron acceptor conditions characterized in the studies.

It is more difficult to relate the  $H_2$  concentrations, both from the known field characterization data and the study parameters since no PCP degradation studies were found that directly measured  $H_2$  and  $H_2$  was not measured in the field. One study parameter that has been collected in the field and in some of the studies that can potentially be correlated to  $H_2$  concentrations is volatile fatty acids, simple organic compounds that can form  $H_2$  through fermentation. Another study parameter that was measured that can be related to  $H_2$  concentrations is microbial C (carbon). The latter is an analytical measure to approximate the soil labile organic carbon. Soil labile organic carbon is defined as the microbial degradable carbon associated with microbial growth (Zou et al, 2005), and is then the carbon available in a soil or aquifer matrix that is potentially available for formation of  $H_2$ . No directly comparable field parameter to microbial C has been collected but estimates of the microbial C from the total organic carbon data collected in the field were performed; the results are discussed in Section 1.3. Another indirect measure of the presence of  $H_2$  is the daughter products of PCP, the presence of which indicate that substitution of the chlorines by hydrogen atoms has occurred. The PCP daughter products have been analyzed in some of the studies and also in the field; the results are also discussed in Section 1.3.

The final condition for PCP degradation to occur is the microbial strains that will degrade the PCP. Although measured in some of the studies described below, no comparable field measurements have been performed. Therefore, this parameter is not discussed further in this technical memorandum.

The literature review performed searched in general for studies of PCP under anaerobic conditions and specifically for direct or indirect electron donor and electron acceptor information that would be or not be conducive to PCP degradation for the conditions where PCP is present at the site. Searches for ranges of rate constants for PCP degradation under the same conditions were also performed. The information from the pertinent articles is summarized below.

#### 1.1.2 PCP Degradation Literature Review

Madsen, T. and Aamand, J. (Madsen and Aamand 1991) studied the degradation of PCP from a PCP-degrading, mixed culture enriched from municipal digester sludge, supplemented with vitamins and 0.1% (wt/vol) yeast extract. Complete degradation under methanogenic conditions was obtained but it was found that the addition of different forms of sulfate inhibited the PCP degradation.

Hi, Q. and Sanford, R.A (Hi and Sanford 2003) studied the degradation of chlorophenol under iron-reducing conditions, with 2mM acetate added as a nutrient. They found there was rapid dechlorination only after complete reduction of the soluble Fe (supplied as 5 mM fumerate).

Aronson, D. and Howard, P.H. (Aronson and Howard, 1997) summarized the studies performed on PCP degradation as part of a larger compilation of anaerobic biodegradation of organic chemicals in groundwater. They concluded that at the time of the preparation of the compilation there was positive evidence of PCP degradation from only one study, that of Fu, K and O'Toole, R (Fu and O'Toole 1990), which reported PCP degradation under nitrate-reducing conditions. This occurred in an active groundwater extraction, treatment, and recirculation system.

Chang, Bea-Ven, et. al, (Chang, et. al 1996) studied PCP degradation in soil slurries using different soil types (sandy loam, partial clay, partial silt, and organic matter) under different laboratory conditions, which included nitrate-, manganese-, iron-, and sulfate-reducing, and methanogenic conditions, and addition of

lactate, pyruvate, and acetate as degradation enhancers. They found complete PCP dechlorination for the sulfate-reducing and methanogenic conditions but complete inhibition of PCP dechlorination under nitrate-, manganese-, and iron-reducing conditions. Addition of lactate, pyruvate, or acetate enhanced the dechlorination under sulfate-reducing and methanogenic conditions.

D'Angelo, E.M and Reddy, K.R. (D'Angelo and Reddy 2000) performed an extensive study of the degradation of PCP in slurries using different organic (6) and mineral (3) wetland soils under different laboratory conditions, which included different electron acceptors [nitrate, iron, and sulfate, and carbon dioxide (methanogenic)], correlation of degradation rates with the total soil property C (carbon), N (nitrogen), P (phosphorus), and microbial C, supplementation of slurries with different electron donors and nutrients [16 treatments (control, inorganic nutrients, inorganic nutrients + vitamins, catechol, benzoate, casein, yeast extract, peptone, glucose, sucrose, maleic acid, fructose, maltose, acetic acid, ethanol, propionate, and hydrogen], and aerobic and anaerobic conditions. They found that PCP degradation under anaerobic conditions was inhibited in 1) all soils but one organic soil under nitrate-reducing conditions, 2) in all soils under iron-reducing conditions, and 3) in all but three of the soils, all organic, under sulfate-reducing conditions. They also found that PCP degradation occurred in all the organic soils under anaerobic, methanogenic conditions and in all the organic soils plus one of the mineral soils under aerobic conditions. The dominant mechanism of the PCP degradation under methanogenic conditions was found to be sequential reductive dechlorination to PCP daughter products tetrachlorophenol, trichlorophenol, and dichlorophenol.

In addition, it was found for the methanogenic conditions with the organic soils, that the C, N, and P content, and the microbial C, were highly correlated with the PCP degradation rates, with the microbial C showing the highest correlation. They also found that dissolved PCP concentrations  $>10$  to  $14\ \mu\text{M}$  (2.6-3.7 ppm PCP) and  $<0.3\ \mu\text{M}$  ( $<79$  ppb PCP) inhibited the PCP degradation under all electron acceptor and soil conditions, which they attributed to toxicity and bioavailability, respectively.



They conducted additional studies on the effect of the 16 different electron donor/nutrient amendments as listed in the previous paragraph on one of the mineral soils where no PCP degradation was found in the unamended treatments. They found that PCP degradation continued to be inhibited under nitrate-, iron-, and to some extent sulfate-reducing conditions but that PCP degradation under methanogenic conditions beyond that found in the control was enhanced only by the addition of yeast extract and peptone. They concluded the degradation enhancement by the protein-based electron donors, along with the high correlation of degradation rate with microbial C, indicated the likely involvement of proteolytic and amino-acid fermenting bacteria involvement in the PCP degradation and the primary role that electron donors and microorganisms played in regulating the PCP reductive dechlorination. Overall, they concluded from the study that nitrate and ferric iron inhibited PCP degradation, noting that this is consistent with the paradigm advanced by Chang et al., 1996 that nitrate and ferric iron reducers outcompete chlorines for common electron-donors. They also noted that that the three of six organic soils where PCP degradation was observed under sulfate-reducing conditions potentially indicated that the PCP degradation was more limited under sulfate-reducing compared to methanogenic conditions but that the PCP chlorines competed with some of the sulfate electron acceptors.

Calculated first order rate constants ranged from 0.0012 to 0.0056/day for aerobic conditions and 0.08-0.39/day for anaerobic, methanogenic conditions.

#### 1.1.3 Relation of PCP Literature Review Results to PCP Degradation at the McCormick and Baxter Groundwater

The literature results were first related to the geochemical conditions that are present at the site in the areas of and the areas downgradient and below the areas of PCP contamination. PCP is present in three general areas, with geochemical conditions as follows: 1) methanogenic conditions in and immediately downgradient of the high PCP concentration areas in the A-zone, 2) primarily iron- and nitrate-reducing, with some sulfate-reducing

conditions, in areas sidegradient of the high concentration PCP contamination area in the A-zone and 3) methanogenic conditions for the wells in the zones lower than the A-zone with generally lower level, isolated PCP detections (USACE 2010).

The literature review found that PCP degradation under the anaerobic conditions that exist in the McCormick and Baxter PCP contaminated groundwater is expected to be inhibited by nitrate-, iron-, and to some extent sulfate-reducing conditions. This information can be related to the site conditions for PCP contamination located sidegradient of the PCP high concentration areas in the A-zone, which are largely iron-reducing or nitrate-reducing, with some sulfate-reducing areas. This would suggest that little or no PCP degradation would be expected to occur in the iron-reducing and nitrate-reducing areas and limited PCP degradation in the sulfate-reducing areas. This conclusion is supported by the field data showing no detections of volatile fatty acids or PCP daughter products in any of the wells in these areas.

The literature review also indicated the potential that PCP degradation occurs under methanogenic conditions but within the restraints of adequate concentrations of electron donor. As indicated above, methanogenic conditions exist in, immediately downgradient, and below (in the lower aquifers) the high PCP concentration areas in the A-zone. In the D'Angelo and Reddy (2000) study, adequate concentrations of electron donor were generally microbial carbon concentrations  $> 20$  mmol(Carbon)/kg(soil). To compare this value back to the available field groundwater data, this value was converted to the measured fractional organic carbon concentrations in the site groundwater (Table 1) by multiplying by the average percentage of microbial carbon in total organic carbon (2%) from Paul and Clark (1996). This value was then compared to the fractional organic carbon field data in the McCormick and Baxter groundwater. Details of the calculation are in Appendix 1 and a summary of the calculations in Table 2.

The results indicate that the estimated fractional organic carbon numbers for the soils in the D'Angelo and Reddy (2000) study are approximately 4-300 times higher than the fractional organic

carbon at the McCormick and Baxter site. Based on this comparison alone, the D'Angelo and Reddy (2010) study would indicate that PCP degradation would be expected to be limited in the methanogenic conditions with the lower fractional organic carbon in the McCormick and Baxter groundwater. However, volatile fatty acids have been detected in a number of the wells where PCP is present under methanogenic conditions [Table 2.9) and two of the same sequential reductive dechlorination PCP daughter products (trichlorophenol and dichlorophenol) identified in the D'Angelo study are present in three of the wells with PCP detections [ Table 3 (from USACE 2010)]. Also, several wells in the D- and E-zone have had PCP detections as well as PCP daughter products in areas of methanogenic conditions (Tables 2 and 3). The presence of the volatile fatty acids, the PCP reductive dechlorination daughter products, along with large PCP concentration decrease (four orders of magnitude over approximately 1500 feet in the downgradient direction in methanogenic conditions) all support PCP degradation in the methanogenic conditions in the McCormick and Baxter groundwater. One of the reasons for the apparent PCP degradation at the lower fractional organic carbon at the site may be the much higher organic compound concentrations [measured naphthalene concentrations 6.5-13 ppm (USACE 2010)], as well as potential lower molecular organic compounds from prior use of diesel in tie-treating operations), compared to the D'Angelo and Redding (2010) study.

The levels of PCP concentrations above which there was apparent toxicity to microbial strains that would degrade PCP from the D'Angelo study were also compared to the PCP concentrations in the McCormick and Baxter groundwater where there was evidence of PCP degradation from the presence of volatile fatty acids and PCP daughter products. The well with the highest measured PCP concentrations, MW-1A [6.5-13 ppm (USACE 2010 and Table 4)], had significant concentrations (up to 19 ppb) PCP daughter products. In a similar fashion, the PCP concentration below which no PCP degradation occurred in the D'Angelo and Reddy study (78 ppb), attributed to insufficient bioavailability, was compared to the well with the highest PCP daughter product concentrations, MW-13B, where PCP daughter products of up to 25 ppb have been

detected with PCP concentrations of ~60 ppb. Also, some wells with non-detect PCP in the E-zone (Table 4) have detectable amounts of PCP daughter products. These comparisons appear to indicate that the PCP concentration limits above which PCP toxicity occur are much higher in the site groundwater and the PCP concentrations below which there is insufficient bioavailability are similar or lower in the site groundwater. However, the wider apparent spread of PCP concentration over which PCP degradation occurs in the site groundwater may be reflected in the lower apparent PCP rate constants in the site groundwater. Screening level PCP rate constants from modeling of field data indicate a range of 0.001-0.0024/day in the site groundwater compared to the rate constants from the D'Angelo and Reddy study of 0.08-0.39/day

The general conclusions from the literature search and the application of the results of the literature search to the site groundwater support little or no degradation of PCP in the areas of nitrate- and iron-reducing conditions, limited degradation of PCP under sulfate-reducing conditions, and the potential for PCP degradation under methanogenic conditions. Although the lower apparent fractional organic carbon at the site compared to those calculated from the D'Angelo and Redding (2000) study would argue for limited PCP degradation in the groundwater at the site, there is evidence of PCP degradation under methanogenic conditions from 1) the presence of PCP daughter products and volatile fatty acids and 2) the large PCP decreases over relatively short distances. Also, it appears that the PCP levels at which toxicity to microbial strains that degrade PCP in the McCormick and Baxter groundwater are higher than those in the D'Angelo and Redding (2000) study. In addition, PCP degradation concentration limits based on bioavailability appear to be lower in the McCormick and Baxter groundwater than in the D'Angelo and Redding (2000) study. The larger PCP concentration range in which PCP appears to occur in the McCormick and Baxter groundwater may be due to the higher organic compound concentrations present due to the general residual creosote contamination. However, the rates constants from screening level modeling of site field data are approximately an order of magnitude lower than those measured in the D'Angelo and



Redding (2000) study, which may indicate less optimum conditions for PCP degradation in the site groundwater compared to those in the D'Angelo and Redding (2000) study.

## 1.2 Naphthalene and Acenaphthene Literature Review

### Introduction

In contrast to the PCP contamination, which is largely confined to the uppermost groundwater zone, the A-zone, the PAH contamination is present in all the groundwater zones (A-E zones) for which samples have been collected and analyzed. In addition, both naphthalene and acenaphthene have migrated beyond the site property boundary in the downgradient direction (USACE 2010). Anaerobic conditions exist both within, upgradient, sidegradient, and downgradient of the PAH contamination, with significant PAH contamination present under nitrate-, iron-, and sulfate-reducing, and methanogenic geochemical conditions. Although the mechanism of anaerobic PAH degradation is not well developed, generally PAH degradation is expected to decrease as the geochemical conditions become less reducing. This is in contrast to PCP, where PCP degradation decreases as the geochemical conditions become less reducing.

The literature search concentrated on naphthalene, which the PAH with generally the highest concentrations, and acenaphthene, the PAH that has migrated the furthest in the downgradient direction. Since naphthalene, a two-ring PAH, is smaller than acenaphthene, a three-ring PAH, naphthalene is generally expected to degrade more easily than acenaphthene (Aronson et al).

Table 1 summarizes the results from the PAH degradation literature search. The first study listed, that of Aronson et al, contained a compilation of naphthalene and acenaphthene degradation studies performed under anaerobic conditions. The Aronson et al compilation found no studies where naphthalene or acenaphthene degraded under nitrate-reducing conditions. For naphthalene, some of the studies showed degradation under iron-reducing, sulfate-reducing, and methanogenic conditions and some studies did not. For acenaphthene, Aronson et al indicated that only a few studies had been performed with no degradation shown in these studies, but the limited length of the studies precluded making a definite conclusion that acenaphthene would not degrade at all under anaerobic conditions.

The individual studies following the Aronson et al study compilation indicate that the most common geochemical condition under which naphthalene degradation was shown to occur was sulfate-reducing, with some studies showing and others not showing naphthalene degrading under nitrate-reducing conditions. Three individual studies were found that studied naphthalene degradation under methanogenic conditions, all of which indicated naphthalene

degradation. Only two studies were found that studied acenaphthene degradation, one under nitrate-reducing conditions and one under sulfate-reducing conditions. Both studies indicated that acenaphthene degradation occurred. An additional study found another three-ring PAH, phenanthrene, that degraded under sulfate-reducing conditions, which by similarity to the three-ring acenaphthene, may indicate the potential for acenaphthene degradation.

Aronson et al compiled rate constants over the entire range of geochemical conditions within their compilation of anaerobic degradation studies. The range of degradation rates for naphthalene was 0.00018-0.043/day, with the average anaerobic rate constant of 0.00072/day. Aronson et al also calculated a range of degradation rates for acenaphthene of 0 to a maximum of 0.0043/day, which was calculated from the single study found with acenaphthene degradation.

Table 1 Summary of Results from PAH Degradation Literature Search		
Study	Naphthalene	Acenaphthene
Aronson, Dallas; Howard, Phillip H. Nov. 12, 1997. <u>Anaerobic Degradation of Organic Chemicals in Groundwater: A Summary of Field and Laboratory Studies.</u>		
Nitrate Reducing	None documented	None documented
Sulfate Reducing	Yes but not all	Perhaps (length of studies too short)
Methanogenic	Yes but not all	Perhaps (length of studies too short)
Iron(III)	Yes but not all	
Coates, John D; Woodward, Joan; Allen, John; Philip, Paul; Lovley, Derek R. <u>Anaerobic Degradation of Polycyclic Aromatic Hydrocarbons and Alkanes in Petroleum-Contaminated Marine Harbor Sediments.</u>		
Nitrate Reducing	Not studied	
Sulfate Reducing	Yes	
Methanogenic	Not studied	
Iron(III)	Not studied	
Anderson, Robert T; Rooney-Varga, Juliette N; Gaw, Catherine V; Lovley, Derek R. <u>Aromatic and Polyaromatic Hydrocarbon Degradation Under Fe(III) Reducing – Conditions.</u>		
Nitrate Reducing	Not Studied	
Sulfate Reducing	Not Studied	
Methanogenic	Not Studied	
Iron Reducing	Yes	
Young, Lily Y; Phelps, Craig D. <u>Metabolic Biomarkers for Monitoring in situ Anaerobic Hydrocarbon Degradation.</u>		
Nitrate Reducing	Not Studied	
Sulfate Reducing	Yes	
Methanogenic	Not Studied	
Iron Reducing	Not Studied	



Study		Naphthalene	Acenaphthene
Mihelcic, James R; Luthy, Richard G. <u>Microbial Degradation of Acenaphthene and Naphthalene under Denitrification Conditions in Soil-Water Systems.</u>			
Nitrate Reducing		Yes	
Sulfate Reducing		Not Studied	
Methanogenic		Not Studied	
Iron(III)		Not Studied	
Hayes, Lorey A; Nevin, Kelly P; Lovley, Derek R. <u>Role of Prior Exposure on Anaerobic Degradation of Naphthalene and Phenanthrene in Marine Harbor Sediments.</u>			
Nitrate Reducing		Not Studied	
Sulfate Reducing		Yes	Phenanthrene (another three ring PAH) degraded
Methanogenic		Not Studied	
Iron(III)		Not Studied	
Leduc, R; Samson, R; Al-Bashir, B; Al-Hawari, J; Cseh, T. <u>Biotic and Abiotic Disappearance of Four PAH Compounds from Flooded Soil Under Various Redox Conditions.</u>			
Nitrate Reducing	Yes		Yes
Sulfate Reducing			
Methanogenic			
Iron(III)			
Ramsay, J; Hao Li; Brown, H.S; Ramsay, B. <u>Naphthalene and anthracene mineralization linked to oxygen, nitrate, Fe(III), and sulphate reduction in a mixed microbial population.</u>			
Nitrate Reducing	Yes		
Sulfate Reducing	Yes		
Methanogenic	Not studied		
Iron(III)	Yes		

Study	Naphthalene	Acenaphthene
Brauner, J; Widdowson, M; Novak, J; Nancy G. <u>Biodegradation of a PAH Mixture by Native Subsurface Microbiota</u>		
Nitrate Reducing		
Sulfate Reducing		Yes
Methanogenic		
Iron(III)		
Hudak, J; McDaniel, J; Lee, S; Fuhrman, J. <u>Mineralization Potentials of Aromatic Hydrocarbons by Estuarine Microorganisms: Variations with season, Location, and Bacterioplankton Production.</u>		
Nitrate Reducing		
Sulfate Reducing		
Methanogenic	X (X)	
Iron(III)		
Rockne, K; Chee-Sanford, J; Sanford, R; Hedlund, B; Staley, J; Strand, S. <u>Anaerobic Naphthalene Degradation by Microbial Pure Cultures under Nitrate-Reducing Conditions.</u>		
Nitrate Reducing	Yes	
Sulfate Reducing	Not Studied	
Methanogenic	Not Studied	
Iron Reducing	Not Studied	
Genthner, B.R., Townsend, G.T, Lantz, S.e., and Mueller, J.G. <u>Persistence of Polycyclic Aromatic Hydrocarbon Components of Creosote Under Anaerobic Enrichment Conditions</u>		
Nitrate Reducing	None	
Sulfate Reducing	No conclusion	
Methanogenic	Limited	
Iron Reducing	Not performed	

Study	Naphthalene	Acenaphthene
<u>Bower, EH, McCarty PL Transformation of halogenated organic compounds under denitrification conditions</u>		
Nitrate Reducing	None	
Sulfate Reducing	Not performed	
Methanogenic	Not performed	
Iron(III)	Not performed	
<u>Sharak-Genthner, BR et al. (1997) Persistence of polycyclic aromatic hydrocarbon components of creosote under anaerobic enrichment conditions</u>		
Nitrate Reducing	No (Methylanthracene degraded, though)	
Sulfate Reducing	Uncertain	
Methanogenic	Yes	
Iron(III)	Not studied	

## References

Aronson and Howard (1997), "Final Report: Anaerobic Biodegradation of Organic Chemicals in Groundwater: A Summary of Field and Laboratory Studies", Prepared by: Dallas Aronson and Philip H. Howard, Environmental Science Center, Syracuse Research Corporation, Prepared for: American Petroleum Institute, Chemical Manufacturer's Association, National Council of the Paper Industry for Air and Stream Improvement, Edison Electric Institute, American Forest and Paper Association, November 12, 1997.

Chang, B.V., J.X. Zheng, and S.Y. Yuan.(Chang et al 1996) "Effect of alternative electron donors, acceptors, and inhibitors in pentachlorophenol dechlorination in soil Chemosphere 33:313-320.

D'Angelo, E.M and Reddy, K.R. "Aerobic and Anaerobic Transformations of Pentachlorophenol in Wetland Soils, Soil Sci. Soc. Am. J. 64:933-943 (2000)

Fu,K & O'Toole,R. Biodegradation of PCP contaminated soils using in situ subsurface bioreclamation. In: Gas, Oil, Coal, and Environmental Biotechnology II. Akin,C & Smith,J (eds) Chicago, IL: Institute of Gas Technology 145-169 (1990)

Hi, Qiang and Sanford, R.A. (Hi and Sanford 2003) "Characterization of Fe(III) Reduction by Chlororespiring Anaeromxybacter dahalogenans" Applied and Env Microbiology, May 2003, p 2712-2718

Madsen, T and J Aamand, "Effects of Sulforoxy Anions on Degradation of PCP by a Methanogenic Enrichment Culture", Applied and Env Microbiology, Sept 1991, p. 2454-2458.

Paul, E.A., Clark, F.E., (Paul and Clark 1996) Soil Microbiology and Biochemistry, Academic Press, New York, NY, 1996.

US Army Corps of Engineers (USACE 2010), "Final 2007-2009 Groundwater Monitoring Report", prepared by the Department of Army US Army Corps of Engineers, Seattle District for Region IX EPA, 28 August 2010.

Zou, X.M., Ruan, H.H., Fu, Y., Yang, X.D, and Sha, L.Q. "Estimating soil labile organic carbon and potential turnover rates using a sequential fumigation-incubation procedure" Soil Biology and Biochemistry 37(2005) 1923-1928



Table 1 Fractional Organic Carbon for Different Aquifer Zone, McCormick and Baxter Groundwater [from US Army Corps of Engineers (USACE 2000) "1999 NAPL Field Investigation Report", prepared by U.S. Army Corps of Engineers, Seattle District and URS Greiner Woodward Clyde for the U.S. Environmental Protection Agency, Region 9, June 2, 2000]

Soil Boring	Boring Depth (ft)	Elevation Ground Surface (ft)	Elevation (ft NAVD88)	Zone	Fraction organic carbon	Avg	Min	Max
A-zone								
SE-010	13	13.34	0.34	A	0.00066			
SB-047	22	8.6	-13.4	A	0.00033			
SE-093	27	9.7	-17.3	A	0.00024			
SE-010	31	13.34	-17.66	A	0.00031			
SE-088	37	12.1	-24.9	A	0.00047			
SE-064	42	14.02	-27.98	A	0.00045			
SE-079	49	10.17	-38.83	A	0.00017			
SE-035	54	14.31	-39.69	A	0.00028			
SE-035	59	14.31	-44.69	A	0.00025			
						0.0003511	0.00017	0.00066
B-zone								
SE-079	63	10.17	-52.83	B	0.00033			
SE-079	63	10.17	-52.83	B	0.00064			
SE-064	68	14.02	-53.98	B	0.00039			
SE-096	74	10.6	-63.4	B	0.00025			
SE-097	76	10.9	-65.1	B	0.00031			
SE-096	78	10.6	-67.4	B	0.00017			
SB-018	81	11.79	-69.21	B	0.00032			
					0.0003443	0.0003443	0.00017	0.00064
C-zone								
SB-018	91	11.79	-79.21	C	0.00018			
SB-047	103	8.6	-94.4	C	0.00058			
SB-099	112	15.02	-96.98	C	0.00043			
SB-018	109	11.79	-97.21	C	0.00028			
SB-099	119	15.02	-103.98	C	0.0014			
SB-047	117	8.6	-108.4	C	0.00034			
					0.000535	0.000535	0.00018	0.0014
D-zone								
SB-047	161	8.6	-152.4	D	0.00063			
SB-099	172	15.02	-156.98	D	0.0019			
					0.001265	0.001265	0.00063	0.0019
E-zone								
SB-018	183	11.79	-171.21	E	0.00021			
SB-099	193	15.02	-177.98	E	0.00088			
SB-047	210	8.6	-201.4	E	0.0013			
SB-099	248	15.02	-232.98	E	0.00094			
SB-047	244	8.6	-235.4	E	0.0008			
					0.000826	0.000826	0.0008	0.0013
0.000826 overall fractional organic carbon average								

Table 2 Conversions of microbial carbon to estimated fractional organic carbon from D'Angelo and Reddy (2000), comparison to fractional organic carbon in A-zone groundwater at McCormick and Baxter								
Soil	Range of microbial carbon (mmol/kg)		Range of microbial carbon fraction (kg/kg)		Estimated fractional organic carbon (microbial carbon fraction divided by 0.02)			Range and average of fractional organic carbon, McCormick and Baxter Groundwater (USACE 2000, see Table 1)
	Low	High	Low	High	Low	High	Average	
Organic	23	97	0.000276	0.001164	0.0138	0.0582	0.036	Range: 0.00017-0.0019
Mineral	13	31	0.000156	0.000372	0.0078	0.0186	0.0132	Average: 0.000826
Estimated fractional organic carbon in D'Angelo and Redding (2000) ~ 4-300 X higher than at McCormick and Baxter								
Soil data from D'Angelo, E.M and Reddy, K.R.(2000)								
Conversion from microbial carbon to fractional organic carbon Zou, et al (2005), which references Paul and Clark (1996)								
Paul, E.A., Clark, F.E., 1996 Soil Microbiology and Biochemistry, Academic Press, New York, NY. for the 1-3 % contribution of microbial carbon to the soil total organic carbon								

[illegible]

Table 4 PCP Degradation Daughter Products		Name:	2,3,5-Trichlorophenol		2,4,6-Trichlorophenol		2,4-dichlorophenol		Pentachlorophenol	
		CAS_RN:	95-95-4		88-06-2		120-83-2		87-86-5	
		Units:	ug/l		ug/l		ug/l		ug/l	
Well ID	Date	Aquifer Zone	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
MW-1A	04/27/2007	A	1	U	1	U	4.8		11000	
MW-1A	04/27/2007	A	1	U	1	U	1	U	13000	
MW-1A	10/22/2008	A	4.1	J-	10		13		9700	
MW-1A	03/23/2009	A	6		6.4		15	J	6500	
MW-13B	10/24/2007	B	19		1	U	1	U	64	J+
MW-13B	10/30/2008	B	1	U	1	U	17		62	
MW-13B	03/26/2009	B	1	U	25		18			
MW-9B	05/03/2007	B	1	U	1	U	1	U	1	U
MW-9B	10/29/2007	B	0.9	U	0.9	U	0.9	U	0.9	UJ
MW-9B	11/03/2008	B	1	U	1	U	1	U	1	U
MW-9B	04/06/2009	B	1	U	1	UJ	1	U	1	U
ONS-1C	04/23/2007	C	0.9	J	1.7		4		2.9	
ONS-1C	10/15/2007	C	1.4		1.4		5.2		1.4	
ONS-1C	10/20/2008	C	1	J	0.7	J	6.9	J	2.4	J
ONS-1C	03/24/2009	C	0.6	J	0.7	J	13		4.3	
OS-1C	05/01/2007	C	1	U	1	U	1	U	1	U
OS-1C	10/24/2007	C	1	U	1	U	1	U	1	U
OS-1C	10/29/2008	C	0.9	U	0.9	U	0.9	U	0.9	U
OS-1C	04/01/2009	C	1.1	U	1.1	U	1.1	U	1.1	U
MW-20E	04/23/2007	E	1	UJ	1	UJ	0.5	J	1	UJ
MW-20E	10/15/2007	E	0.9	U	0.9	U	0.9	U	0.9	U
MW-20E	10/20/2008	E	1	UJ	1	U	1	U	1	UJ
MW-20E	03/24/2009	E	0.9	U	0.9	U	0.5	J	0.9	
MW-21E	04/23/2007	E	1	U	1	U	2.1		1	U
MW-21E	10/15/2007	E	1	U	1	U	1	U	1	U
MW-21E	10/20/2008	E	1	UJ	1	U	1	U	1	UJ
MW-21E	03/24/2009	E	0.9	U	0.9	U	0.5	J	1.9	J
OS-3E	05/01/2007	E	1	U	1	U	1	U	1	U
OS-3E	10/25/2007	E	1	U	1	U	1	U	1	UJ
OS-3E	10/23/2008	E	0.9	U	0.9	U	0.9	U	0.9	U
OS-3E	04/02/2009	E	0.6	J	1	UJ	1	U	1	U



## Appendix 1 Estimation and comparison of fractional organic carbon from soils in D'Angelo and Reedy (2000) Study and comparison with fractional organic carbon from McCormick and Baxter groundwater

The microbial carbon in the D'Angelo and Reedy (2000) study ranged between 23-97 mmol/kg for the organic soils and 13-31 mmol/kg for the mineral soils. Using an average of 2% microbial carbon per total soil organic carbon (range of 1-3%) from Paul, E.A., Clark, F.E., 1996 Soil Microbiology and Biochemistry, Academic Press, New York, NY as quoted from Zou, X.M., Ruan, H.H., Fu, Y., Yang, X.D, and Sha, L.Q. "Estimating soil labile organic carbon and potential turnover rates using a sequential fumigation-incubation procedure" Soil Biology and Biochemistry 37(2005) 1923-1928, with the molecular weight of 12 g/mole for carbon, the estimated fractional organic carbon (wt/wt) for the organic soils is 0.0138-0.0582 and 0.0078-0.0186 for the mineral soils. This compares to the average fractional organic carbon at McCormick and Baxter of 0.000826. See Tables 1 and 2 in the text for a summary of the calculations.


**ATTACHMENT D**  
**Focused Feasibility Study Cost Estimate Review**

Description: This cost estimate review was completed by the U.S. Army Corps of Engineers, Mobile Environmental & Munitions Center of Expertise and Mobile District on behalf of U.S. EPA Region 4. USACE reviewed the cost estimates included in the Focused Feasibility Study (Black & Veatch, 2014). The intent of this exercise was to provide a high-level review, identifying findings such as significant unit rate changes which may have occurred in recent years, excessively high/low costs, etc.

- **Cost Element: Steam-Enhanced Extraction**
  - Overall, the units and unit rates are lower than reasonable. The vendors indicate unit costs may be as low as \$80/cy but are typically over \$100/cy. The FS-estimated unit cost of \$68/cy is outside the range. To develop an accurate current cost, it would likely be necessary to contact a vendor.
- **Cost Element: Slurry Wall**
  - The unit price for the slurry wall (per square foot) is high. Literature values are more on the order of \$7-10/square foot.
- **Cost Element: Surfactant-Enhanced Aquifer Remediation (SEAR) – HAPA**
  - Overall, there seems to be a lack of O&M costs to extract groundwater from the areas that are subject to surfactant injections; even though the element description acknowledges that groundwater would be extracted. It's likely that the treatment system would be somewhat complex given the need to separate the surfactants, and residual NAPL, and groundwater. If this type of treatment/extraction system operated for 2-5 years at an annual cost of \$250,000/year, that could be \$1,250,000 in unaccounted costs.
- **Cost Element: In-Situ Enhanced Bioremediation (ISEB) of the SA and HAPA**
  - There is a discrepancy between the duration of system operations in the element description (5 year) and the O&M costs (10 years). Nothing in the cost estimate directly indicates which value was intended. It appears that 10 years was maybe intended for an unselected alternative, S3, which did not include aggressive SA treatment.
  - The annual cost to operate and maintain the ISEB injection system (\$60,000) seems low, although there is little to scrutinize because there is no description of treatment volumes, air delivery rates, etc. Note that a higher annual O&M cost could be offset by fewer years of operation (see earlier bullet).
- **Cost Element: Demolition and Decommissioning**
  - Given the damage to the sheet pile wall that occurred after the FFS was prepared, this unit rate is likely low. It may not be possible to remove the badly bent sections of the wall using simple pulling/hammering with an excavator. Assume that this unit price could be double (\$100,000 instead of \$50,000).
- **Cost Element: Borrow/Fill Materials – Acquisition and Handling (fill in SWMU 10 excavation)**
  - This Cost Element isn't included in the FS Cost for the Selected Alternative, S4, but should be to the extent needed to implement the remedy. For remedy implementation, the actual volume of fill soil wouldn't need to be 120,000 cy but could be between 15,000 cy and 40,000 cy. Unit rates could probably be lowered if a local fill source is available (\$7/cubic yard instead of \$11.50/cubic yard).
- **Groundwater Monitoring Well – Installation and Maintenance (Shallow Wells)**
  - It's unlikely that a direct push (DPT) rig is going to be used to install a monitoring well. The cost/foot to drill, log, install, and develop the monitoring well is low, could be

increased to \$100/foot instead of \$48.5/foot. Cost impact would equate to an additional ~\$20,000.

- It's unclear why 30 years of O&M is included if the FFS is just focusing on remedy implementation in the SA and HAPA, and the long-term plan is for the FDEP to manage the site. If the O&M cost were removed, it would save ~\$5,700.
- **Groundwater Monitoring Well – Installation and Maintenance (Deep Wells)**
  - The number of wells seems small; 10 wells seems more appropriate than 5 wells. Cost impact would equate to an additional ~\$70,000.
  - The unit costs for the deep monitoring wells (~49/foot) seem very low for all aspects of installation. Real costs may be double this value.
  - It's unclear why 30 years of O&M is included if the FFS is just focusing on remedy implementation in the SA and HAPA, and the long-term plan is for the FDEP to manage the site. If the O&M cost were removed, it would save ~\$5,700.
- **Cost Element: Environmental Monitoring (General)**
  - Cost per sample seems low; in the short term, additional analytical parameters would likely be tested including possibly VOCs, metals, general chemistry parameters. Assume that cost per sample could be \$300/sample. instead of \$100/sample.
  - As with previous comments, including costs for 30 years of sampling seems unnecessary if the FFS is just focusing on remedy implementation in the SA and HAPA, and the long-term plan is for the FDEP to manage the site.
  - Making these two revisions would result in a cost savings.
- **Cost Element: Post-Remedy Site Restoration (Cleanup, Grading / Earthwork, Re-Seeding)**
  - The cost element to import clean topsoil seems unnecessary given the current and future use of the site. Removing this element would save ~\$100,000.



